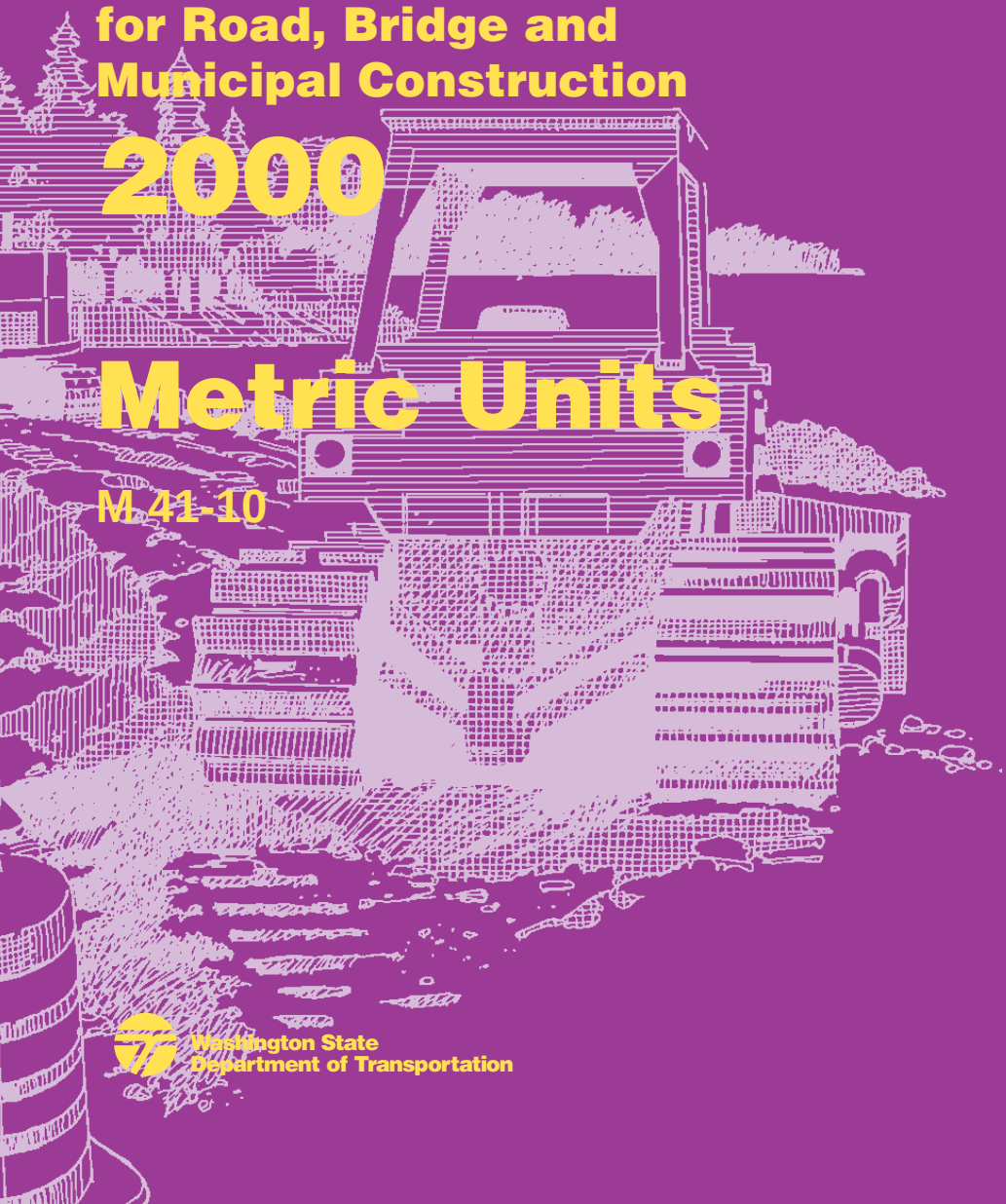
Standard Specifications

for Road, Bridge and Municipal Construction

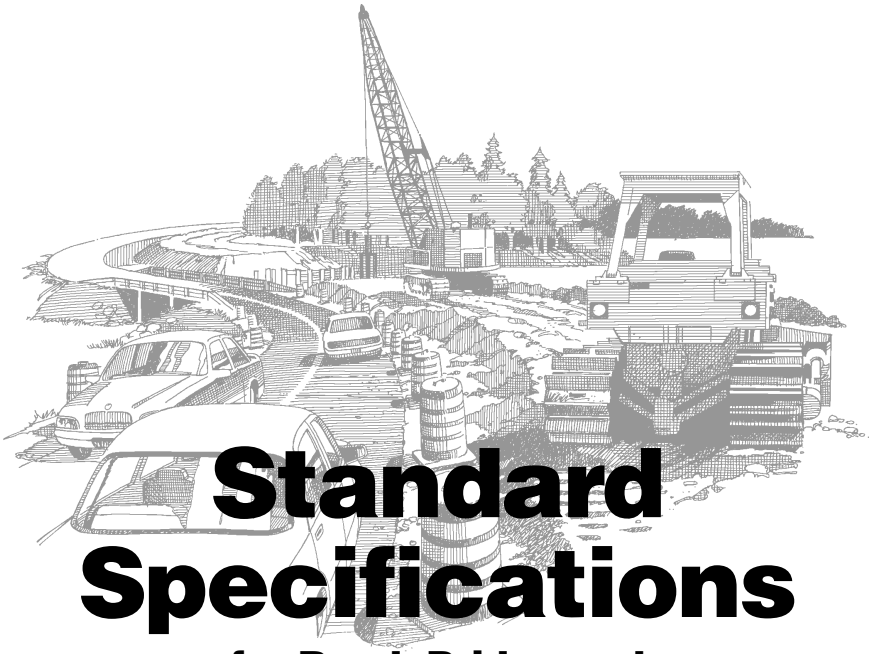
2000

Metric Units

M 41-10



Washington State
Department of Transportation



Standard Specifications

for Road, Bridge and Municipal Construction

2000

Metric Units

M 41-10

Washington State
Department of Transportation

American Public Works Association

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DIVISION 1
GENERAL REQUIREMENTS

1-01 DEFINITIONS AND TERMS

1-01.1 General

The following abbreviations and terms are defined here as they are used in any contract documents and specifications. When used in the proposal form to denote items of work and units of measurements, abbreviations are defined to mean the full expression.

1-01.2 Abbreviations

1-01.2(1) Associations and Miscellaneous

These abbreviations are used in plans and specifications as defined here:

AAA	American Arbitration Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AGC	Associated General Contractors of America
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMS	Aerospace Material Specification
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARA	American Railway Association
AREA	American Railway Engineering Association
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
CFR	Code of Federal Regulations
CLI	Chain Link Institute
CRAB	County Road Administration Board
CRSI	Concrete Reinforcing Steel Institute
DIPRA	Ductile Iron Pipe Research Association

EEI	Edison Electric Institute
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards, General Services Administration
HUD	United States Department of Housing and Urban Development
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
IES	Illumination Engineering Society
IMSA	International Municipal Signal Association
LID	Local Improvement District
LPI	Lighting Protection Institute
MSHA	Mine Safety and Health Act
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NRMCA	National Ready Mix Concrete Association
OMWBE	Office of Minority and Women's Business Enterprises
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PPI	Plastic Pipe Institute
P/PCI	Precast/Prestressed Concrete Institute
RCW	Revised Code of Washington (Laws of the State)
RID	Road Improvement District
SAE	Society of Automotive Engineers
SEPA	State Environmental Policy Act
SSPC	Steel Structures Painting Council
TIB	Transportation Improvement Board
UL	Underwriter Laboratory
ULID	Utility Local Improvement District
UMTA	Urban Mass Transit Administration
WAC	Washington Administrative Code
WCLIB	West Coast Lumber Inspection Bureau
WISHA	Washington Industrial Safety and Health Administration
WRI	Wire Reinforcement Institute
WSDOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation
WWPA	Western Wood Products Association

1-01.2(2) Items of Work and Units of Measurement

Plans and specifications may include common engineering and construction abbreviations. Many such abbreviations need no definition. But when the following abbreviations are used, they will only mean:

ACP	Asphalt Concrete Pavement
Agg.	Aggregate
Al.	Aluminum

ATB	Asphalt Treated Base
BST	Bituminous Surface Treatment
Cl.	Class
Comb.	Combination
Conc.	Concrete
Crib.	Cribbing
Culv.	Culvert
°C	Degree Celsius
Diam.	Diameter
Est.	Estimate or Estimated
Excl.	Excluding
g	Gram
Hund.	Hundred
Incl.	Including
kg	Kilograms
km	Kilometer
kPa	Kilopascal
L	Liter
LS	Lump Sum
m	Meter
m^2	Square Meter(s)
m^3	Cubic Meter(s)
mm	Millimeter
mm^2	Square Millimeter(s)
MPa	Megapascal
N	Newton
N•m	Newton•Meter
Pa	Pascal
Pres.	Pressure
PVC	Polyvinyl Chloride
Reg.	Regulator
Reinf.	Reinforced, Reinforcing
Sec.	Section
St.	Steel
Str.	Structural
t	Tonne(s) (1000 kilograms)
Th.	Thick or Thickness
Tr.	Treatment
VC	Vitrified Clay

1-01.3 Definitions

Addendum

A written or graphic document, issued to all bidders and identified as an addendum prior to bid opening, which modifies or supplements the bid documents and becomes a part of the contract.

Auxiliary Lane

The part of the roadway next to traveled ways for parking, speed changes, turning, weaving, truck climbing or for anything that adds to through traffic movement.

Award

The formal decision of the Contracting Agency to accept the lowest responsible and responsive bidder for the work.

Bid, Proposal

The offer of a bidder on a properly completed proposal form to perform the contract.

Bidder

An individual, partnership, firm, corporation, or joint venture, submitting a proposal or bid. When required by law or otherwise the individual, partnership, firm, corporation, or joint venture shall be prequalified.

Bid Documents

The component parts of the proposed contract which may include, but are not limited to, the proposal form, the proposed contract provisions, the proposed contract plans, addenda, and subsurface boring logs (if any).

Bridge Approach Embankments

An embankment beneath a structure and extending 30 meters beyond a structure's end (at subgrade elevation for the full embankment width) plus an access ramp on a 1:10 slope to the original ground elevation. Also, any embankment that replaces unsuitable foundation soil beneath the bridge approach embankment.

Call for Bids (Advertisement for Bids)

The published public notice soliciting proposals or bids for work stating, among other things, the time, place, and date for receiving and opening the bids.

Commission, Washington State Transportation Commission

The appointive body having authority over state transportation matters as provided by law.

Completion Dates

Substantial Completion Date is the day the Engineer determines the Contracting Agency has full and unrestricted use and benefit of the facilities, both from the operational and safety standpoint, and only minor incidental work, replacement of temporary substitute facilities, or correction or repair remains for the physical completion of the total contract.

Physical Completion Date is the day all of the work is physically completed on the project. All documentation required by the contract and required by law does not necessarily need to be furnished by the Contractor by this date.

Completion Date is the day all the work specified in the contract is completed and all the obligations of the Contractor under the contract are fulfilled by the Contractor. All documentation required by the contract and required by law must be furnished by the Contractor before establishment of this date.

Contract

The written agreement between the Contracting Agency and the Contractor. It describes, among other things:

1. What work will be done, and by when;
2. Who provides labor and materials; and
3. How Contractors will be paid.

The contract includes the contract (agreement) form, bidder's completed proposal form, contract provisions, contract plans, standard specifications, standard plans, addenda, various certifications and affidavits, supplemental agreements, change orders, and subsurface boring logs (if any).

Contract Bond

The approved form of security furnished by the Contractor and the Contractor's surety as required by the contract, that guarantees performance of all the work required by the contract and payment to anyone who provides supplies or labor for the performance of the work.

Contract Form (Agreement Form)

The form provided by the Contracting Agency that requires the authorized signatures of the Contractor and the Contracting Agency to result in formal execution of the contract.

Contracting Agency

Agency of Government that is responsible for the execution and administration of the contract.

Contractor

The individual, partnership, firm, corporation, or joint venture, contracting with the Contracting Agency to do prescribed work.

Contract Plans

A publication addressing the work required for an individual project. At the time of the call for bids, the contract plans may include, but are not limited to, the following: a vicinity map, a summary of quantities, structure notes, signing information, traffic control plans, and detailed drawings; all for a specific individual project. At the time of the contract execution date, the contract plans include any addenda.

Contract Provisions

A publication addressing the work required for an individual project. At the time of the call for bids, the contract provisions may include, for a specific individual project, the amendments to the standard specifications, the special provisions, a listing of the applicable standard plans, the prevailing minimum hourly wage rates, and an informational proposal form with the listing of bid items. The proposed contract provisions may also include, for a specific individual project, the Required Contract Provisions Federal-aid Construction Contracts, and various required certifications or declarations. At the time of the contract execution date, the contract provisions include the proposed contract provisions and include any addenda, a copy of the contract form, and a copy of the proposal form with the contract prices and extensions.

Department, Department of Transportation

The State Agency authorized by law to administer transportation-related work.

Engineer

The Contracting Agency's representative who administers the construction program for the Contracting Agency.

Federal Highway Administration

The Federal Agency authorized to approve plans and contracts for Federal-Aid Highway projects. They also inspect such projects to ensure contract compliance.

Frontage Road

A local street or road usually next to an arterial highway that serves abutting property and adjacent areas and controls access.

Highway

A public way for vehicles, including the entire right of way.

Inspector

The Project Engineer's representative who inspects contract performance in detail.

Laboratory

The laboratories of the Contracting Agency, or other laboratories the Contracting Agency authorizes to test work, soils, and materials.

Plans

The contract plans or standard plans which show location, character, and dimensions of prescribed work including layouts, profiles, cross-sections, and other details.

Project Engineer

The Engineer's representative who directly supervises the engineering and administration of a construction project.

Proposal Form

The form provided to bidders by the Contracting Agency for submittal of a proposal or bid to the Contracting Agency for a specific project. The form includes the item number, estimated plan quantity, and item description of the bid items along with blank spaces to be completed by the bidder for the unit prices, extensions, the total bid amount, signatures, date, acknowledgment of addenda, and the bidder's address. The required certifications and declarations are part of the form.

Right of Way

Land, property, or property interest, usually in a strip, acquired for or devoted to transportation purposes.

Roadbed

The graded part of the roadway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

Roadway

The portion of the right of way within the outside limits of the side slopes.

Secretary, Secretary of Transportation

The chief executive officer of the Department and other authorized representatives.

Shoulder

The part of the roadway next to the traveled way or auxiliary lanes. It provides lateral support of base and surface courses and is an emergency stopping area for vehicles.

Slope Ratios

The vertical component is shown first and horizontal second. For slopes less than 45 degrees, the vertical component is unitary. For slopes over 45 degrees, the horizontal component is unitary.

Special Provisions

Supplemental specifications and modifications to the standard specifications and the amendments to the standard specifications that apply to an individual project.

Specifications

Provisions and requirements for the prescribed work.

Standard Plans

A manual of specific plans or drawings adopted by the Contracting Agency which show frequently recurring components of work that have been standardized for use.

State

The state of Washington acting through its representatives.

Structures

Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, service pipes, sewers, underdrains, foundation drains, and other features found during work that the contract may or may not classify as a structure.

Subcontractor

An individual, partnership, firm, corporation, or joint venture who is sublet part of the contract by the Contractor.

Subgrade

The top surface of the roadbed on which subbase, base, surfacing, pavement, or layers of similar materials are placed.

Substructure

The part of the structure *below*:

1. The bottom of the grout pad for the simple and continuous span bearing, or
2. The bottom of the girder or bottom slab soffit, or
3. Arch skewbacks and construction joints at the top of vertical abutment members or rigid frame piers.

Substructures include endwalls, wingwalls, barrier and railing attached to the wingwalls, and cantilever barriers and railings.

Superstructure

The part of the structure *above*:

1. The bottom of the grout pad for the simple and continuous span bearing, or
2. The bottom of the girder or bottom slab soffit, or
3. Arch skewbacks and construction joints at the top of vertical abutment members or rigid frame piers.

and extending:

1. from the back of pavement seat to the back of pavement seat when the endwalls are attached to the superstructure, or
2. from the expansion joint at the end pier to the expansion joint at the other end pier when the endwalls are not attached to the superstructure.

Superstructures include, but are not limited to, girders, slab, barrier, and railing attached to the superstructure.

Superstructures do not include endwalls, wingwalls, barrier and railing attached to the wingwalls, and cantilever barriers and railings unless supported by the superstructure.

Surety

A company that is bound with the Contractor to ensure performance of the contract, payment of all obligations pertaining to the work, and fulfillment of such other conditions as are specified in the contract, contract bond, or otherwise required by law.

Titles (or Headings)

The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Traveled Way

That part of the roadway made for vehicle travel excluding shoulders and auxiliary lanes.

Work

The provision of all labor, materials, tools, equipment, and everything needed to successfully complete a project according to the contract.

Working Drawings

Shop drawings, shop plans, erection plans, falsework plans, framework plans, cofferdam, cribbing and shoring plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data, including a schedule of submittal dates for working drawings where specified, which the Contractor must submit to the Engineer for approval.

1-02 BID PROCEDURES AND CONDITIONS

1-02.1 Prequalification of Bidders

The Contracting Agency will provide a bid proposal form only after a prospective bidder submits a "Standard Questionnaire and Financial Statement." This questionnaire enables the Contracting Agency to decide whether or not the bidder is qualified to perform highway, road, or other public work. The questionnaire shall be sworn to before a person authorized to take oaths.

On the basis of this questionnaire, the Contracting Agency will either specify the type and amount of work it considers the prospective bidder prequalified to perform or advise the prospective bidder of the reasons they failed to be prequalified. To remain prequalified, the bidder must submit an updated questionnaire once a year and supplements whenever required by the Contracting Agency.

A submittal deadline applies to any prospective bidder not prequalified or from whom a supplemental questionnaire is due. To receive consideration for issuance of a bid proposal form on a specific project, the questionnaire (or supplement) must be received by the Prequalification Engineer no less than 15 days prior to the scheduled bid opening.

The Contracting Agency may withdraw a bidder's prequalification or reduce its amount if:

1. The extent of other work the bidder has under contract (Contracting Agency or otherwise) justifies such action, or
2. Past or present work on a Contracting Agency contract has been less than satisfactory.

If a bidder's questionnaire does not contain sufficient information, the Contracting Agency may refuse to provide a bid proposal form and disregard any bid submitted. After opening bids, the Contracting Agency may decide that a prequalified bidder is not responsible and may refuse to accept the bid on that basis. Such a refusal will be conclusive unless the bidder appeals within five days to the Superior Court of Thurston County. Any appeal shall be heard within ten days after it is filed and shall provide at least five days' notice to the Contracting Agency.

The bidder shall ensure that the combination of the bid amount and other contract work with the Contracting Agency does not exceed the prequalification amount. If this combination does exceed the prequalification amount, the Contracting Agency may determine the bidder to be not responsible and refuse to award a contract.

Two or more prospective bidders may, in a joint venture, prequalify and bid jointly on a single contract. Each shall have filed a "Standard Questionnaire and Financial Statement." Together they shall also file a standard form of "Individual Project Statement of Joint Venture" and a joint venture agreement in a form acceptable to the Contracting Agency.

To bid jointly on a continuous joint venture on more than one contract, two or more prospective bidders shall submit:

1. A "Standard Questionnaire and Financial Statement" compiled for the joint venture;
2. A "Standard Questionnaire and Financial Statement" for each member (if the Contracting Agency has no copy on file); and
3. A copy of the "Joint Venture Agreement" signed by each member of the joint venture and naming each person authorized to sign documents on its behalf. (If any member is a corporation, a corporate resolution shall accompany the

agreement. This resolution shall authorize the joint venture agreement and name the officer(s) authorized to sign the joint venture agreement or contract on behalf of the corporation.)

The Contracting Agency will treat the continuing joint venture as a new firm and decide its prequalification on that basis.

Any joint venture and each of its members is subject to Section 1-02.14.

1-02.2 Plans and Specifications

The Contracting Agency will place review copies of the plans and specifications on file in the offices of:

1. All Regional Administrators of the Department,
2. The County Engineer of the county in which the work is located, and
3. These plans service offices of the Associated General Contractors of America: Seattle, Spokane, and Tacoma, Washington.

Prospective bidders may purchase plans and specifications from the Department of Transportation in Olympia, Washington, for the fee given in the call for bids. The fee shall accompany each request for plans. Checks shall be payable to the State of Washington, Department of Transportation.

After award of the contract, the plans and specifications will be issued without charge on the following basis:

To Prime Contractor	**No. of Sets**	**Basis of Distribution**
Reduced plans (215 mm × 280 mm) and special provisions	10	Furnished automatically upon award.
Additional reduced plans (215 mm × 280 mm) and special provisions	10	Furnished only upon request for projects with more than 100 plan sheets.
Large plans (560 mm × 865 mm) and special provisions	1	Furnished only upon request.
Additional large plans (560 mm × 865 mm) and special provisions	1	Furnished only upon request for projects with more than 100 plan sheets.

To Subcontractors and Suppliers	**No. of Sets**	**Basis of Distribution**
Reduced plans (215 mm × 280 mm) and accompanying special provisions	1	Furnished only upon request by the Prime Contractor for an approved subcontractor or material supplier.

Additional plans may be purchased by payment of the current rates.

1-02.3 Estimated Quantities

The quantities shown in the proposal form and the contract forms are estimates and are stated only for bid comparison purposes. The Contracting Agency does not warrant expressly or by implication, that the actual quantities of work will correspond with those estimates. Payment will be made on the basis of the actual quantities of each item of work completed in accordance with the contract requirements.

1-02.4 Examination of Plans, Specifications, and Site of Work

1-02.4(1) General

The bidder shall carefully examine the bid documents as defined in Section 1-01.3. Submittal of a bid shall be conclusive evidence that the bidder has made these examinations and understands all requirements for the performance of the completed work. The bidder further warrants, agrees, and acknowledges by submitting a bid that it:

1. Has taken steps reasonably necessary to ascertain the nature and location of the work;
2. Has investigated and satisfied itself as to the general and local conditions which can affect the work or its cost, including but not limited to:
   a. Conditions bearing upon acquisition, transportation, disposal, handling, and storage of materials;
   b. The availability of labor, materials, water, electric power, and roads;
   c. Uncertainties of weather, river stages, tides, or similar physical conditions at the site;
   d. The conformation and condition of the ground; and
   e. The character of equipment and facilities needed preliminary to and during work performance;
3. Has satisfied itself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the work site (including material sites) as well as from the bid documents and other information made a part of this contract; and
4. Has satisfied itself as to the adequacy of time allowed for the completion of the physical work on the contract.

Any failure of the bidder to take the actions described and acknowledged in this clause shall not relieve the bidder from responsibility for estimating properly the difficulty and cost of successfully performing the work, or from proceeding to successfully perform the work without additional expense to the Contracting Agency.

The bidder agrees that the Contracting Agency shall not be liable to it on any claim for additional payment or additional time or any claim whatsoever if the claim directly or indirectly results from the bidder's failure to investigate and familiarize itself sufficiently with the conditions under which the contract is to be performed.

The bidder shall be familiar and comply with all Federal, State, and local laws, ordinances, and regulations which might affect those engaged in the work. The Contracting Agency will not consider any plea of misunderstanding or ignorance of such requirements.

Bid prices shall reflect what the bidder anticipates to be the cost of completing the work, including methods, materials, labor, and equipment. Except as the contract may provide, the bidder shall receive no payment for any costs that exceed those in the bid prices.

Prospective bidders are advised that projects with work on or adjacent to water may require insurance coverage in compliance with:

1. The Longshoremen's and Harbor Worker's Compensation Act (administered by U.S. Department of Labor), or
2. The State Industrial Insurance (administrated by the Washington State Department of Labor and Industries), or
3. Both.

The Contractor shall bear all cost for such insurance as provided in Section 1-07.10.

No Claim shall be allowed because of any ambiguity in the contract if:

1. The bidder discovers an ambiguity but fails to notify the Contracting Agency; or
2. The bidder failed to discover a patent ambiguity that would be discovered by a reasonably prudent contractor in preparing its bid.

Any prospective bidder desiring an explanation or interpretation of the bid documents, must request the explanation or interpretation in writing soon enough to allow a written reply to reach all prospective bidders before the submission of their bids. Oral explanations, interpretations, or instructions given by anyone before the award of a contract will not be binding on the Contracting Agency. Any information given a prospective bidder concerning any of the bid documents will be furnished to all prospective bidders as an addendum if that information is deemed by the Contracting Agency to be necessary in submitting bids or if the Contracting Agency concludes that the lack of the information would be prejudicial to other prospective bidders.

1-02.4(2) Subsurface Information

If the Contracting Agency has made subsurface investigation of the site of the proposed work, the boring log data and soil sample test data accumulated by the Contracting Agency will be made available for inspection by the bidders. The boring logs shall be considered as part of the contract. However, the Contracting Agency makes no representation or warranty expressed or implied that:

1. The bidders' interpretations from the boring logs are correct;
2. Moisture conditions and indicated water tables will not vary from those found at the time the borings were made; and
3. The ground at the location of the borings has not been physically disturbed or altered after the boring was made.

The Contracting Agency specifically makes no representations, guarantees, or warranties as to the condition, materials, or proportions of the materials between the specific borings regardless of any subsurface information the Contracting Agency may make available to the prospective bidders.

The availability of subsurface information from the Contracting Agency shall not relieve the bidder or the Contractor from any risks or of any duty to make examinations and investigations as required by Section 1-02.4(1) or any other responsibility under the contract or as may be required by law.

1-02.5 Proposal Forms

At the request of a prequalified bidder, the Contracting Agency will provide a proposal form for any project on which the bidder is eligible to bid.

The proposal form will identify the project and its location and describe the work. It will also list estimated quantities, units of measurement, the items of work, and the materials to be furnished at the unit bid prices. The bidder shall complete spaces on the proposal form that call for unit prices, extensions, the total bid amount, signatures, date, acknowledgment of addenda, and the bidder's address. The required certifications are included as part of the proposal form.

1-02.6 Preparation of Proposal

The Contracting Agency will accept only those proposals properly executed on forms it provides. Unless it approves in writing, the Contracting Agency will not accept proposals on forms attached to the Plans and stamped "Informational".

Any unit price that is left blank or does not contain numeric figures will be considered no charge for that bid item. The extension for that bid item will also be treated as no charge and reflected as such in the total contract price regardless of what has been placed in the extension column.

All prices shall be in legible figures (not words) written in ink or typed. The proposal shall include:

1. A unit price for each item (omitting digits more than four places to the right of the decimal point),
2. An extension for each unit price (omitting digits more than two places to the right of the decimal point), and
3. The total contract price (the sum of all extensions).

In the space provided on the signature sheet, the bidder shall confirm that all addenda has been received.

The bidder shall submit a completed "Disadvantaged, Minority or Women's Business Enterprise Certification" if it applies.

The bidder shall submit with the bid a list of:

1. Subcontractors who will perform the work of heating, ventilation and air conditioning, plumbing as described in Chapter 18.106 RCW and electrical as described in Chapter 19.28 RCW, and
2. The work those subcontractors will perform on the contract.
3. Shall not list more than one subcontractor for each category of work identified, except, when subcontractors very with bid alternates, in which case the bidder shall identify which subcontractor will be used for which alternate.

If no subcontractor is listed, the bidder acknowledges that it does not intend to use any subcontractor to perform those items of work;

If the contract provisions establish a minimum bid amount for the item "Traffic Control Labor", the bid for the item in the proposal shall equal or exceed that amount.

Proposals of corporations shall be signed by the officer or officers having authority to sign them. If a bidder is a copartnership, the proposal shall be signed by an authorized member of the copartnership. When the bidder is a joint venture, the proposal shall be signed by one or more individuals as authorized by the Joint Venture.

1-02.7 Bid Deposit

A deposit of at least 5 percent of the total bid shall accompany each bid. This deposit may be by cash, certified check, cashier's check, or a proposal bond (surety bond). Any proposal bond shall be on a form acceptable to the Contracting Agency and shall be signed by the bidder and the surety. A proposal bond shall not be conditioned in any way to modify the minimum 5 percent required. The surety shall: (1) be registered with the Washington State Insurance Commissioner, and (2) appear on the current Authorized Insurance List in the State of Washington published by the Office of the Insurance Commissioner.

The failure to furnish a bid deposit of a minimum of 5 percent shall make the bid nonresponsive and shall cause the bid to be rejected by the Contracting Agency.

1-02.8 Noncollusion Declaration and Lobbying Certification

1-02.8(1) Noncollusion Declaration

When required by Section 112(c) Title 23, United States Code, a declaration shall be provided certifying that the bidder has not taken part in collusion or other action that would restrain competitive bidding.

The Code of Federal Regulations [23 CFR Part 635.107(i)(1)] requires that: "Each bidder shall file a sworn or unsworn statement executed by, or on behalf of the person, firm, association, or corporation submitting the bid, certifying that such persons, firm, association, or corporation has not either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid. Failure to submit the sworn or unsworn statement as part of the bid proposal package will make the bid nonresponsive and not eligible for award consideration." In addition, 23 CFR Part 635.107(i) requires that the Contracting Agency provide the form for the declaration to prospective bidders and that the declaration shall be executed by such persons, firm, association, or corporation under penalty of perjury under the laws of the United States.

Therefore, by signing the proposal, the bidder will be deemed to have signed and agreed to the requirements of the Noncollusion Declaration.

1-02.8(2) Lobbying Certification

Section 319 of Public Law 101-121 prohibits payment of Federal Funds for contract lobbying by the Contractor and any subcontractor or lower tier subcontractor whose contract exceeds $100,000. A Certification for Federal-Aid Contracts (Form DOT 272-040) is provided in the proposal form for contracts exceeding $100,000 to address this requirement.

By signing the proposal, the bidder will be deemed to have signed and agreed to the conditions and requirements of the Certification for Federal-Aid Contracts.

The Contractor shall ensure that a Certification for Federal-Aid Contracts (Form DOT 272-040) is included in every contract with any subcontractor or lower tier subcontractor whose contract exceeds $100,000. By signing the contract any subcontractor or lower tier subcontractor will be deemed to have signed and agreed to the conditions and requirements of the Certification for Federal-Aid Contracts. The Contractor shall keep evidence in their files that such subcontractor or lower tier subcontractor has committed to this requirement.

Section 319 of Public Law 101-121 also provides that, if any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the Contractor shall complete and submit to the Contracting Agency the Standard Form LLL, DISCLOSURE OF LOBBYING ACTIVITIES, in accordance with the instructions on the form. Any subcontractor or lower tier subcontractor whose contract exceeds $100,000 shall disclose in the same manner as the Contractor, except that, Standard Form LLL shall be submitted to the Contractor for processing to the Contracting Agency.

Audits will be conducted to ensure compliance with this section.

The Certification for Federal-Aid Contracts (Form DOT 272-040) may be reproduced from the proposal form. The disclosure form is available from the Washington State Department of Transportation's Pre-Contract Office, Transportation Building, Olympia, Washington 98504.

1-02.9 Delivery of Proposal

Each proposal shall be sealed and submitted in the envelope provided with it. The bidder shall fill in all blanks on this envelope to ensure proper handling and delivery.

The Contracting Agency will not consider proposals it receives after the time fixed for opening bids in the call for bids.

1-02.10 Withdrawal or Revision of Proposal

After submitting a bid proposal to the Contracting Agency, the bidder may withdraw or revise it if:

1. The bidder submits a written request signed by an authorized person, and
2. The Contracting Agency receives the request before the time for opening bids.

The original bid proposal may be revised and resubmitted as the official bid proposal if the Contracting Agency receives it before the time for opening bids.

1-02.11 Combination and Multiple Proposals

A project may be organized for bidding and construction by various methods to enable proposals to be submitted for combined projects or for the construction method specified. The Contracting Agency reserves the right to award combined or separate bids or by such other method deemed most advantageous to the Contracting Agency. Only those combined bids specifically prescribed in the project special provisions will be accepted. If contracts are awarded for combinations of projects, separate contracts will be written for each project included in the combination.

A bidder submitting more than one proposal at a letting may attach one of the following statements to each proposal:

"We prefer to be awarded not more than (Number) contracts for projects for which we have submitted bids at this letting;" or

"We prefer to be awarded contracts of a total value of not more than $____ for projects for which we have submitted bids at this letting."

Such attachments will not make the proposals irregular. The Contracting Agency will award each contract to the lowest responsible bidder but will consider such attachment in determining the responsibility of the bidder to perform each contract for which a statement has been attached.

1-02.12 Public Opening of Proposals

Proposals will be opened and publicly read at the time indicated in the call for bids unless the bid opening has been delayed or canceled. Bidders, their authorized agents, and other interested parties are invited to be present.

1-02.13 Irregular Proposals

1. A proposal will be considered irregular and will be rejected if:
   a. The bidder is not prequalified;
   b. The authorized proposal form furnished by the Contracting Agency is not used or is altered;

c. The completed proposal form contains any unauthorized additions, deletions, alternate bids, or conditions;
d. The bidder adds provisions reserving the right to reject or accept the award, or enter into the contract;
e. A price per unit cannot be determined from the bid proposal;
f. The proposal form is not properly executed;
g. The bidder fails to submit or properly complete a subcontractor list, if applicable, as required in Section 1-02.6.
h. The bidder fails to submit or properly complete a Disadvantaged, Minority or Women's Business Enterprise Certification, if applicable, as required in Section 1-02.6; or
i. The bid proposal does not constitute a definite and unqualified offer to meet the material terms of the bid invitation.

2. A proposal may be considered irregular and may be rejected if:
   a. Any of the unit prices are excessively unbalanced (either above or below the amount of a reasonable bid) to the potential detriment of the Contracting Agency;
   b. Receipt of addenda is not acknowledged;
   c. A member of a joint venture or partnership and the joint venture or partnership submit proposals for the same project (in such an instance, both bids may be rejected); or
   d. If proposal form entries are not made in ink.

1-02.14 Disqualification of Bidders

A bidder may be deemed not responsible and the proposal rejected if:

1. More than one proposal is submitted for the same project from a bidder under the same or different names;
2. Evidence of collusion exists with any other bidder. Participants in collusion will be restricted from submitting further bids;
3. A bidder is not prequalified for the work or to the full extent of the bid;
4. An unsatisfactory performance record exists based on past or current Contracting Agency work;
5. There is uncompleted work (Contracting Agency or otherwise) which might hinder or prevent the prompt completion of the work bid upon;
6. The bidder failed to settle bills for labor or materials on past or current contracts;
7. The bidder has failed to complete a written public contract or has been convicted of a crime arising from a previous public contract;
8. The bidder is unable, financially or otherwise, to perform the work;
9. A bidder is not authorized to do business in the state of Washington; or
10. There are any other reasons deemed proper by the Contracting Agency.

1-02.15 Pre-Award Information

Before awarding any contract, the Contracting Agency may require one or more of these items or actions of the apparent lowest responsible bidder:

1. A complete statement of the origin, composition, and manufacture of any or all materials to be used,
2. Samples of these materials for quality and fitness tests,
3. A progress schedule (in a form the Contracting Agency requires) showing the order of and time required for the various phases of the work,
4. A breakdown of costs assigned to any bid item,
5. Attendance at a conference with the Engineer or representatives of the Engineer, or
6. Any other information or action taken that is deemed necessary to ensure that the bidder is the lowest responsible bidder.

1-03 AWARD AND EXECUTION OF CONTRACT

1-03.1 Consideration of Bids

After opening and reading proposals, the Contracting Agency will check them for correctness of extensions of the prices per unit and the total price. If a discrepancy exists between the price per unit and the extended amount of any bid item, the price per unit will control. The total of extensions, corrected where necessary, will be used by the Contracting Agency for award purposes and to fix the amount of the contract bond.

The right is reserved by the Contracting Agency to waive informalities in the bidding, accept a proposal of the lowest responsible bidder, reject any or all bids, republish the call for bids, revise or cancel the work, or require the work to be done in another way if the best interest of the Contracting Agency is served.

A bidder who wishes to claim error after the bids have been publicly opened and read as required by RCW 47.28.090 shall promptly notify the Contracting Agency that an error occurred. The bidder shall submit a notarized affadavit or declaration under penalty of perjury signed by the bidder and accompanied by the work sheets used in the preparation of the bid, requesting relief from the responsibilities of award. The affidavit or declaration shall describe the specific error(s) and certify that the work sheets are the ones used in preparing the bid.

The affidavit or declaration shall be submitted no later than 5:00 p.m. on the first business day after bid opening or the claim will not be considered. The Contracting Agency will review the affidavit or delcaration and the certified work sheets to determine the validity of the claimed error and if the error is of the kind for which the law allows relief from forfeiture of the bid deposit. If the Contracting Agency concurs in the claim of error and determines that the error is of the kind which allows relief from forfeiture, the bidder will be relieved of responsibility and the bid deposit of the bidder will be returned. If the Contracting Agency does not concur in the error or determines that the error is not the kind for which the law allows relief, the Contracting Agency may award the contract and if the bidder refuses to execute the contract, the bidder's bid deposit shall be forfeited as required by RCW 47.28.100.

1-03.2 Award of Contract

Normally, contract award or bid rejection will occur within 45 calendar days after bid opening. If the lowest responsible bidder and the Contracting Agency agree, this deadline may be extended. If they cannot agree on an extension by the 45 calendar day deadline, the Contracting Agency reserves the right to award the contract to the next lowest responsible bidder or reject all bids. The Contracting Agency will notify the successful bidder of the contract award in writing.

1-03.3 Execution of Contract

Within 20 calendar days after the award date, the successful bidder shall return the signed Contracting Agency-prepared contract, an insurance certification as required by Section 1-07.18, and a satisfactory bond as required by law and Section 1-03.4. Before execution of the contract by the Contracting Agency, the successful bidder shall provide any pre-award information the Contracting Agency may require under Section 1-02.15.

Until the Contracting Agency executes a contract, no proposal shall bind the Contracting Agency nor shall any work begin within the project limits or within Contracting Agency-furnished sites. The Contractor shall bear all risks for any work begun outside such areas and for any materials ordered before the contract is executed by the Contracting Agency.

If the bidder experiences circumstances beyond their control that prevents return of the contract documents within 20 calendar days after the award date, the Contracting Agency may grant up to a maximum of 20 additional calendar days for return of the documents, provided the Contracting Agency deems the circumstances warrant it.

1-03.4 Contract Bond

The successful bidder shall provide an executed contract bond for the full contract amount. This contract bond shall:

1. Be on a Contracting Agency-furnished form;
2. Be signed by an approved surety (or sureties) that:
   a. Is registered with the Washington State Insurance Commissioner, and
   b. Appears on the current Authorized Insurance List in the State of Washington published by the Office of the Insurance Commissioner,
3. Be conditioned upon the faithful performance of the contract by the Contractor within the prescribed time; and
4. Guarantee that the surety shall indemnify, defend, and protect the Contracting Agency against any claim of direct or indirect loss resulting from the failure:
   a. Of the Contractor (or any of the employees, subcontractors, or lower tier subcontractors of the Contractor) to faithfully perform the contract, or
   b. Of the Contractor (or the subcontractors or lower tier subcontractors of the Contractor) to pay all laborers, mechanics, subcontractors, lower tier subcontractors, materialperson, or any other person who provides supplies or provisions for carrying out the work.

The Contracting Agency may require sureties or surety companies on the contract bond to appear and qualify themselves. Whenever the Contracting Agency deems the surety or sureties to be inadequate, it may, upon written demand, require the Contractor to furnish additional surety to cover any remaining work. Until the added surety is furnished, payments on the contract will stop.

1-03.5 Failure to Execute Contract

Failure to return the insurance certification and bond with the signed contract as required in Section 1-03.3, or failure to provide Disadvantaged, Minority or Women's Business Enterprise information if required in the contract, or failure or refusal to sign the contract shall result in forfeiture of the proposal bond or deposit of this bidder. If this should occur, the Contracting Agency may then award the contract to the second lowest responsible bidder or reject all remaining bids. If the second lowest responsible bidder fails to return the required documents as stated above within the time provided after award, the contract may then be awarded successively in a like manner to the remaining lowest responsible bidders until the above requirements are met or the remaining proposals are rejected.

1-03.6 Return of Bid Deposit

When proposals have been examined and corrected as necessary, proposal bonds and deposits accompanying proposals ineligible for further consideration will be returned. All other proposal bonds and deposits will be held until the contract has been properly executed. When the contract has been properly executed, all remaining deposits or bonds, except those subject to forfeiture, will be returned.

1-03.7 Judicial Review

Any decision made by the Contracting Agency regarding the award and execution of the contract or bid rejection shall be conclusive subject to the scope of judicial review permitted under Washington Law. Such review, if any, shall be timely filed in the Superior Court of Thurston County, Washington.

1-04 SCOPE OF THE WORK

1-04.1 Intent of the Contract

The intent of the contract is to prescribe a complete work. Omissions from the contract of details of work which are necessary to carry out the intent of the contract shall not relieve the Contractor from performing the omitted work.

1-04.1(1) Bid Items Included in the Proposal

The Contractor shall provide all labor, materials, tools, equipment, transportation, supplies, and incidentals required to complete all work for the items included in the proposal.

1-04.1(2) Bid Items Not Included in the Proposal

When the contract specifies work that has no bid item, and the work is not specified as being included with or incidental to other bid items, an equitable adjustment will be made in accordance with Section 1-04.4 unless that work is customarily considered as incidental to other items.

1-04.2 Coordination of Contract Documents, Plans, Special Provisions Specifications, and Addenda

The complete contract includes these parts: the contract form, bidder's completed proposal form, contract plans, contract provisions, standard specifications, standard plans, addenda, various certifications and affidavits, supplemental agreements, change orders, and subsurface boring logs (if any). These parts complement each other in describing a complete work. Any requirement in one part binds as if stated in all parts. The Contractor shall provide any work or materials clearly implied in the contract even if the contract does not mention it specifically.

Any inconsistency in the parts of the contract shall be resolved by following this order of precedence (e.g., 1 presiding over 2, 3, 4, 5, 6, and 7; 2 presiding over 3, 4, 5, 6, and 7; and so forth):

1. Addenda,
2. Proposal Form,
3. Special Provisions,
4. Contract Plans,
5. Amendments to the Standard Specifications,
6. Standard Specifications, and
7. Standard Plans.

On the contract plans, working drawings, and standard plans, figured dimensions shall take precedence over scaled dimensions.

This order of precedence shall not apply when work is required by one part of the contract but omitted from another part or parts of the contract. The work required in one part must be furnished even if not mentioned in other parts of the contract.

If any part of the contract requires work that does not include a description for how the work is to be performed, the work shall be performed in accordance with standard trade practice(s). For purposes of the contract, a standard trade practice is one having such regularity of observance in the trade as to justify an expectation that it will be observed by the Contractor in doing the work.

In case of any ambiguity or dispute over interpreting the contract, the Engineer's decision will be final as provided in Section 1-05.1.

1-04.3 Vacant

1-04.4 Changes

The Engineer reserves the right to make, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as altered. Among others, these changes and alterations may include:

1. Deleting any part of the work,
2. Increasing or decreasing quantities,
3. Altering specifications, designs, or both,
4. Altering the way the work is to be done,
5. Adding new work,
6. Altering facilities, equipment, materials, services, or sites, provided by the Contracting Agency.
7. Ordering the Contractor to speed up or delay the work.

The Engineer will issue a written change order for any change unless the remainder of this section provides otherwise.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable. If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract. The term *significant change* shall be construed to apply only to the following circumstances:

A. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or
B. When a major item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. For the purpose of this section, a major item of work will be defined as any item that qualifies for adjustment under the provisions of Section 1-04.6.

For Item 1, an equitable adjustment for deleted work will be made as provided in Section 1-09.5.

For Item 2, if the actual quantity of any item increases or decreases by more than 25 percent from the original plan quantity, the unit contract prices for that item may be adjusted in accordance with Section 1-04.6.

For any changes except Item 1 (deleted work) or Item 2 (increasing or decreasing quantities), the Engineer will determine if the change should be paid for at unit contract price(s). If the Engineer determines that the change increased or decreased the Contractor's costs or time to do any of the work including unchanged work, the Engineer will make an equitable adjustment to the contract. The equitable adjustment will be by agreement with the Contractor. However, if the parties are unable to agree, the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4 and adjust the time as the Engineer deems appropriate. Extensions of time will be evaluated in accordance with Section 1-08.8. The Engineer's decision concerning equitable adjustment and extension of time shall be final as provided in Section 1-05.1.

The Contractor shall proceed with the work upon receiving:

1. A written change order approved by the Engineer, or
2. An oral order from the Project Engineer before actually receiving the written change order.

Changes normally noted on field stakes or variations from estimated quantities, except as provided in sub-paragraph A or B above, will not require a written change order. These changes shall be made at the unit prices that apply. The Contractor shall respond immediately to changes shown on field stakes without waiting for further notice.

The Contractor shall obtain written consent of the surety or sureties if the Engineer requests such consent.

The Contracting Agency has a policy for the administration of cost reduction alternatives proposed by the Contractor. The Contractor may submit proposals for changing the Plans, Specifications, or other requirements of the Contract. These proposals must reduce the cost or time required for construction of the project. When determined appropriate by the Contracting Agency, the Contractor will be allowed to share the savings.

Guidelines for submitting Cost Reduction Incentive Proposals are available at the Project Engineer's office. The actions and requirements described in the guidelines are not part of the Contract. The guidelines requirements and the Contracting Agency's decision to accept or reject the Contractor's proposal are not subject to arbitration under the arbitration clause or otherwise subject to litigation.

Contractor proposed changes to substitute items measured in English units in lieu of items measured in Metric units, are not eligible for shared savings. In those instances where substitution is allowed, the full savings will be credited to the Contracting Agency.

1-04.5 Procedure and Protest by the Contractor

If in disagreement with anything required in a change order, another written order, or an oral order from the Engineer, including any direction, instruction, interpretation, or determination by the Engineer, the Contractor shall:

1. Immediately give a signed written notice of protest to the Project Engineer or the Project Engineer's field inspectors before doing the work;
2. Supplement the written protest within 15 calendar days with a written statement providing the following:
   a. The date of the protested order;
   b. The nature and circumstances which caused the protest;
   c. The contract provisions that support the protest;
   d. The estimated dollar cost, if any, of the protested work and how that estimate was determined; and
   e. An analysis of the progress schedule showing the schedule change or disruption if the Contractor is asserting a schedule change or disruption; and
3. If the protest is continuing, the information required above, shall be supplemented as requested by the Project Engineer. In addition, the Contractor shall provide the Project Engineer, before final payment, a written statement of the actual adjustment requested.

Throughout any protested work, the Contractor shall keep complete records of extra costs and time incurred. The Contractor shall permit the Engineer access to these and any other records needed for evaluating the protest as determined by the Engineer.

The Engineer will evaluate all protests provided the procedures in this section are followed. If the Engineer determines that a protest is valid, the Engineer will adjust payment for work or time by an equitable adjustment in accordance with Section 1-09.4. Extensions of time will be evaluated in accordance with Section 1-08.8. No adjustment will be made for an invalid protest.

In spite of any protest, the Contractor shall proceed promptly with the work as the Engineer orders.

The Contractor accepts all requirements of a change order by: (1) endorsing it, (2) writing a separate acceptance, or (3) not protesting in the way this section provides. A change order that is not protested as provided in this section shall be full payment and final settlement of all claims for contract time and for all costs of any kind, including costs of delays, related to any work either covered or affected by the change.

By not protesting as this section provides, the Contractor also waives any additional entitlement and accepts from the Engineer any written or oral order (including directions, instructions, interpretations, and determinations).

By failing to follow the procedures of this section and Section 1-09.11, the Contractor completely waives any claims for protested work.

1-04.6 Increased or Decreased Quantities

Payment to the Contractor will be made only for the actual quantities of work performed and accepted in conformance with the contract. When the accepted quantities of work vary from the original bid quantities, payment will be at the unit contract prices for accepted work unless the total quantity of any contract item, using the original bid quantity, increases or decreases by more than 25 percent. In that case that part of the increase or decrease exceeding 25 percent will be adjusted as follows:

1. Increased Quantities.
   Either party to the contract will be entitled to renegotiate the price for that portion of the actual quantity in excess of 125 percent of the original bid quantity. The price for increased quantities will be determined by agreement of the parties, or, where the parties cannot agree, the price will be determined by the Engineer based upon the actual costs to perform the work, including reasonable markup for overhead and profit.
2. Decreased Quantities.
   Either party to the contract will be entitled to an equitable adjustment if the actual quantity of work performed is less than 75 percent of the original bid quantity. The equitable adjustment in the case of decreased quantities shall be based upon any increase or decrease in costs due solely to the variation of the estimated quantity. The total payment for any item will be limited to no more than 75 percent of the amunt originally bid for the item.
   The following limitations shall apply to the adjustment:

1. The equipment rates shall be actual cost but shall not exceed the rates set forth in the AGC/WSDOT Equipment Rental Agreement in effect at the time the work is performed as referred to in Section 1-09.6.
2. No payment will be made for extended or unabsorbed home office overhead and field overhead expenses to the extent that there is an unbalanced allocation of such expenses among the contract bid items.
3. No payment for consequential damages or loss of anticipated profits will be allowed because of any variance in quantities from those originally shown in the proposal form, contract provision, and contract plans.

When ordered by the Engineer, the Contractor shall proceed with the work pending determination of the cost or time adjustment for the variation in quantities.

The Contracting Agency will not adjust for increases or decreases if the Contracting Agency has entered the amount for the item in the proposal form only to provide a common proposal for bidders.

1-04.7 Differing Site Conditions (Changed Conditions)

The Contractor shall promptly, and before such conditions are disturbed, notify the Engineer in writing of: (1) preexisting subsurface or latent physical conditions at the site differing materially from those indicated in this contract, or (2) preexisting unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inhering in work of the character provided for in this contract. The Engineer will promptly investigate the conditions. If the Engineer finds that conditions are materially different and cause a material increase or decrease in the Contractor's cost of, or the time required for, performance of any part of the work under this contract whether or not changed as a result of such conditions, the Engineer will make an equitable adjustment in the payment or the time required for the performance of the work. Extensions of time will be evaluated in accordance with Section 1-08.8. The equitable adjustment will be by agreement with the Contractor. However, if the parties are unable to agree, the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4. If the Engineer determines that differing site conditions do not exist and no adjustment in costs or time is warranted, such determination shall be final as provided in Section 1-05.1.

No claim of the Contractor, under this clause, shall be allowed unless the Contractor has given the notice required above; provided, however, the time for giving notice will be extended by the Engineer for good cause shown. The time for giving notice will not be extended beyond the time that the Contractor knew or should have known of the existence of the differing site condition. If there is a decrease in the costs or time required to perform the work, failure of the Contractor to notify the Engineer of the differing site condition shall not affect the Contracting Agency's right to make an adjustment in the costs or time.

Additionally, no claim by the Contractor shall be allowed unless the Contractor has followed the procedures provided in Sections 1-04.5 and 1-09.11.

1-04.8 Progress Estimates and Payments

Engineer-issued progress estimates or payments for any part of the work shall not be used as evidence of performance or quantities. Progress estimates serve only as basis for partial payments. The Engineer may revise progress estimates any time before final acceptance. If the Engineer deems it proper to do so, changes may be made in progress estimates and in the final estimate.

1-04.9 Use of Buildings or Structures

The Engineer will decide whether any building or structure on the right of way may remain during the work and whether the Contractor may use such a building or structure.

1-04.10 Use of Materials Found on the Project

With the Engineer's written approval, the Contractor may use on the project: stone, gravel, sand, other materials from on-site excavation, or timbers removed in the course of the work. Approval will not be granted if:

1. The excavated materials or timber fail to meet contract requirements;
2. The excavated materials or timber are required for other use under the contract;
3. The excavated materials are required for use as Selected Materials under Section 2-03.3(10); or
4. Such use is not in the best interests of the Contracting Agency as determined by the Engineer, whose decision shall be final as provided in Section 1-05.1.

Any material disturbed by, but not used in, the work shall be disposed of as provided elsewhere in the contract or as directed by the Engineer.

1-04.11 Final Cleanup

The Contractor shall perform final cleanup as provided in this section to the Engineer's satisfaction. The Engineer will not establish the physical completion date until this is done. The highway right of way, material sites, and all ground the Contractor occupied to do the work shall be left neat and presentable. The Contractor shall:

1. Remove all rubbish, surplus materials, discarded materials, falsework, camp buildings, temporary structures, equipment, and debris; and
2. Deposit in embankments, or remove from the project, all unneeded, oversized rock left from grading, surfacing, or paving.

The Contractor shall not remove warning, regulatory, or guide signs unless the Engineer approves.

1-05 CONTROL OF WORK

1-05.1 Authority of the Engineer

The Engineer shall be satisfied that all the work is being done in accordance with the requirements of the contract. The contract and specifications give the Engineer authority over the work. Whenever it is so provided in this contract, the decision of the Engineer shall be final: provided, however, that if an action is brought within the time allowed in this contract challenging the Engineer's decision, that decision shall be subject to the scope of judicial review provided in such cases under Washington case law.

The Engineer's decisions will be final on all questions including, but not limited to, the following:

1. Quality and acceptability of materials and work,
2. Measurement of unit price work,
3. Acceptability of rates of progress on the work,
4. Interpretation of plans and specifications,
5. Determination as to the existence of changed or differing site conditions,
6. Fulfillment of the contract by the Contractor,
7. Payments under the contract including equitable adjustment,
8. Suspension(s) of work,
9. Termination of the contract for default or public convenience,
10. Determination as to unworkable days, and
11. Approval of working drawings.

The Project Engineer represents the Engineer on the project, with full authority to enforce contract requirements and carry out the Engineer's orders. If the Contractor fails to respond promptly to the requirements of the contract or orders from the Engineer:

1. The Project Engineer may use Contracting Agency resources, other contractors, or other means to accomplish the work, and
2. The Contracting Agency will not be obligated to pay the Contractor, and will deduct from the Contractor's payments any costs that result when any other means are used to carry out the contract requirements or Engineer's orders.

At the Contractor's risk, the Project Engineer may suspend all or part of the work if:

1. The Contractor fails to fulfill contract terms, to carry out the Engineer's orders, or to correct unsafe conditions of any nature;
2. The weather or other conditions are unsuitable; or
3. It is in the public interest.

Nothing in these Specifications or in the contract requires the Engineer to provide the Contractor with direction or advice on how to do the work. If the Engineer approves or recommends any method or manner for doing the work or producing materials, the approval or recommendation shall not:

1. Guarantee that following the method or manner will result in compliance with the contract,
2. Relieve the Contractor of any risks or obligations under the contract, or
3. Create any Contracting Agency liability.

1-05.2 Authority of Assistants and Inspectors

The Project Engineer may appoint assistants and inspectors to assist in determining that the work and materials meet the contract requirements. Assistants and inspectors have the authority to reject defective material and suspend work that is being done improperly, subject to the final decisions of the Project Engineer or, when appropriate, the Engineer.

Assistants and inspectors are not authorized to accept work, to accept materials, to issue instructions, or to give advice that is contrary to the contract. Work done or material furnished which does not meet the contract requirements shall be at the Contractor's risk and shall not be a basis for a claim even if the inspectors or assistants purport to change the contract.

Assistants and inspectors may advise the Contractor of any faulty work or materials or infringements of the terms of the contract; however, failure of the Project Engineer or the assistants or inspectors to advise the Contractor does not constitute acceptance or approval.

1-05.3 Plans and Working Drawings

The contract plans are defined in Section 1-01.3. Any proposed alterations by the Contractor affecting the requirements and information in the contract plans shall be in writing and will require approval of the Engineer. All contractor submittals shall be in metric units. The applicable standard for metric units, terminology, abbreviations, and practive is found in ASTM E 380, Practice for Use of the International System of Units (SI).

To detail and illustrate the work, the Engineer may furnish to the Contractor additional plans and explanations consistent with the original plans. The Contractor shall perform the work according to these additional plans and explanations.

The Contractor shall submit supplemental working drawings as required for the performance of the work. Except as noted, all drawings and other submittals shall be delivered directly to the Project Engineer. The drawings shall be on sheets measuring 22 by 34 inches, 11 by 17 inches, or on sheets with dimensions in multiples of $8^1/_2$ by 11 inches. The drawings shall be provided far enough in advance of actual need to allow for the review process by the Contracting Agency or other agencies. This may involve resubmittals because of revisions or rejections. Unless otherwise stated in the contract, the Engineer will require up to 30 calendar days from the date the submittals or resubmittals are received until they are sent to the Contractor. After a plan or drawing has been approved and returned to the Contractor, all changes that the Contractor proposes shall be submitted to the Project Engineer for review and approval. This time will increase if the drawings submitted do not meet the contract requirements or contain insufficient details.

If more than 30 calendar days are required for the Engineer's review of any individual submittal or resubmittal, an extension of time will be considered in accordance with Section 1-08.8.

The Contractor shall obtain the Engineer's written approval of the drawings before proceeding with the work they represent. This approval shall neither confer upon the Contracting Agency nor relieve the Contractor of any responsibility for the accuracy of the drawings or their conformity with the contract. The Contractor shall bear all risk and all costs of any work delays caused by nonapproval of these drawings or plans.

Unit bid prices shall cover all costs of working drawings.

1-05.4 Conformity With and Deviations From Plans and Stakes

The Special Provisions may require that the Contractor be contractually responsible for part or all of the project surveying. For survey requirements not the responsibility of the Contractor, the engineer will lay out and set construction stakes and marks needed to establish the lines, grades, slopes, cross-sections, and curve superelevations. These stakes and marks will govern the Contractor's work. The Contractor shall take full responsibility for detailed dimensions, elevations, and slopes measured from them.

All work performed shall be in conformity with the lines, grades, slopes, cross sections, superelevation data, and dimensions as shown in the Plans, or as staked. If the Plans, Special Provisions, or these Specifications, state specific tolerances, the work shall be performed within those limits. The Engineer's decision on whether the work is in conformity shall be final, as provided in Section 1-05.1.

The Contractor shall not deviate from the approved plans and working drawings unless the Engineer approves in writing.

When the Contracting Agency is responsible for roadway surveying, and the Contractor trims the subgrade with an automatic machine guided by reference lines. the Engineer will set control stakes for line and grade only once after grading is complete. To gain better control with unusual pavement widths or for other reason, the Engineer may set more control stakes without added cost to the Contractor. The Contractor shall set reference lines from these control stakes for trimming subgrade, for surfacing, and for controlling the paving machines.

The Contractor shall work to preserve stakes, marks, and monuments set by the Engineer. The Contracting Agency will deduct from payments due the Contractor all costs to replace such stakes, marks, and monuments carelessly or willfully damaged or destroyed by the Contractor's operation.

The contractor shall provide enough safe areas to permit the Engineer to set those points and elevations that are the responsibility of the Contracting Agency and to perform random checks of the surveying performed by the contractor.

The Contractor shall keep the engineer informed of staking requirements to provide the Engineer with adequate time to set the stakes for which the contracting Agency is responsible. Contractor requests for stakes shall be made at least three working days before the engineer needs to begin the staking operation.

1-05.5 Vacant

1-05.6 Inspection of Work and Materials

The Engineer may inspect all work and materials for conformity with contract terms. To ensure the Engineer's safety and access during these inspections, the Contractor shall provide any equipment needed, such as walkways, railings, ladders, and platforms.

When the Engineer requests, the Contractor shall (without charge) provide samples of materials used or to be used in the work. If the Contractor uses materials tested and approved for one project in an unrelated project, the Contracting Agency may deduct its testing and inspection costs from payments due the Contractor. The Engineer may order the Contractor to remove and replace, and bear the cost of doing so, any materials used without inspection.

Any inspections, tests, measurements, or other actions by Contracting Agency employees serve only one purpose: to assure the Engineer that work, materials, progress rate, and quantities comply with contract terms. Such work by Contracting Agency employees shall not relieve the Contractor from doing any contract-assigned work or from determining whether contract requirements are being met. The Contractor shall correct any substandard work or materials. The Engineer will reject unsuitable work or materials even though inspected or paid for in a progress estimate.

If the Engineer requests, the Contractor shall remove or uncover any area of the completed work. After the Engineer inspects it, the Contractor shall restore the area to the standard the contract requires. The Contractor shall bear the cost of uncovering, removing, and restoring the exposed work: (a) if it proves unacceptable, or (b) if it was placed without

authority or without due notice to the Engineer. The Contracting Agency will pay these costs by agreed price or by force account if the work proves to be acceptable and the Contractor had performed the original work with the authority of and due notice to the Engineer.

The Contractor, if advised to do so by the Engineer, shall permit representatives from other agencies to inspect the work when it is to be done:

1. On any railroad, utility, or facility of a public agency; or
2. To the satisfaction of any federal, state, or municipal agency.

In any crushing or screening operation, the Contractor shall provide and install a mechanical sampler that:

1. Is automatic or semiautomatic;
2. Can safely and easily obtain representative samples of the materials being produced;
3. Can convey the samples to ground level in Contracting Agency-provided sacks;
4. Moves at an even rate through the full width of the materials stream falling from the discharge end of the belt, gate, or chute;
5. Is power driven during the material intercept cycle; and
6. Can be adjusted to take samples of about 45 kilograms as often as the Engineer requires.

No material from the crushing or screen operation will be accepted until after the Engineer has approved the design and operation of the sampling equipment. The Contractor shall bear all costs of providing the sampling equipment, the power to operate it, and the space for its use.

1-05.7 Removal of Defective and Unauthorized Work

The Contracting Agency will not pay for unauthorized or defective work. Unauthorized or defective work includes: work and materials that do not conform to contract requirements; work done beyond the lines and grades set by the plans or the Engineer; and extra work and materials furnished without the Engineer's written approval. At the Engineer's order, the Contractor shall immediately remedy, remove, replace, or dispose of unauthorized or defective work or materials and bear all costs of doing so.

1-05.8 Vacant

1-05.9 Equipment

At the Engineer's request, the Contractor shall provide an operating and maintenance manual for each model or type of mixing, placing, or processing equipment before using it in the work. The Contractor shall also provide test instruments to confirm whether the equipment meets operating requirements, such as vibration rate, revolutions-per-minute, or any other requirements.

The contract may require automatically controlled equipment for some operations. If the automatic controls on such equipment fails, the Contractor may operate the equipment manually for the remainder of that normal working day, provided the method of operation produces results otherwise meeting the specifications. Continued operation of the equipment manually beyond this working day will be permitted only by specific authorization of the Engineer.

The Engineer will reject equipment that repeatedly breaks down or fails to produce results within the required tolerances. The Contractor shall have no claim for additional payment or for extension of time due to rejection and replacement of any equipment.

1-05.10 Guarantees

The Contractor shall furnish to the Contracting Agency any guarantee or warranty furnished as a customary trade practice in connection with the purchase of any equipment, materials, or items incorporated into the project.

1-05.11 Final Inspection

The Engineer will not make the final inspection until the physical work required by the contract, including final cleanup and all extra work ordered by the Engineer, has been completed. The physical completion date for the contract will be determined as provided in Section 1-08.5.

1-05.12 Final Acceptance

The Contractor must perform all the obligations under the contract before a completion date and final acceptance can occur. Failure of the Contractor to perform all the obligations under the contract shall not bar the Contracting Agency from unilaterally accepting the contract as provided in Section 1-09.9. The Secretary accepts the completed contract and the items of work shown in the final estimate by signature of the Final Contract Voucher Certification. The date of that signature constitutes the acceptance date. Progress estimates or payments shall not be construed as acceptance of any work under the contract.

The Contractor agrees that neither completion nor final acceptance shall relieve the Contractor of the responsibility to indemnify, defend, and protect the Contracting Agency against any claim or loss resulting from the failure of the Contractor (or the subcontractors or lower tier subcontractors) to pay all laborers, mechanics, subcontractors, materialpersons, or any other person who provides labor, supplies, or provisions for carrying out the work or for any payments required for unemployment compensation under Title 50 RCW or for industrial insurance and medical aid required under Title 51 RCW.

Final acceptance shall not constitute acceptance of any unauthorized or defective work or material. The Contracting Agency shall not be barred from requiring the Contractor to remove, replace, repair, or dispose of any unauthorized or defective work or material or from recovering damages for any such work or material.

1-05.13 Superintendents, Labor, and Equipment of Contractor

At all times, the Contractor shall keep at the work site a set of the plans, specifications, special provisions, and addenda. The Contractor shall devote the attention required to make reasonable progress on the work and shall cooperate fully with the Engineer and inspectors.

Either the Contractor in person or an authorized representative shall remain on site whenever the work is underway. Before the work begins, the Contractor shall name in writing an experienced superintendent who understands the contract and is able to supervise the work. This superintendent shall have full authority to represent and act for the Contractor. Any superintendent who repeatedly fails to follow the Engineer's written or oral orders, directions, instructions, or determinations, shall be subject to removal from the project. Upon the written request of the Engineer, the Contractor shall immediately remove such superintendent and name a replacement in writing.

Competent supervisors experienced in the task being performed shall continuously oversee the contract work. At the Engineer's written request, the Contractor shall immediately remove and replace any incompetent, careless, or negligent employee.

Noncompliance with the Engineer's request to remove and replace personnel at any level shall be grounds for terminating the contract under the terms of Section 1-08.10.

The Contractor shall keep all machinery and equipment in good, workable condition. It shall be adequate for its purpose and used by competent operators.

The Engineer will rate the Contractor's performance and contract compliance in these categories:

1. Progress of Work,
2. Quality of Work,
3. Equipment,
4. Administration/Management/Supervision, and
5. Coordination and Control of subcontractors.

Whenever the Contracting Agency evaluates the Contractor's prequalification under RCW 47.28.070, it will take these reports into account.

1-05.14 Cooperation With Other Contractors

The Contracting Agency may perform other work at or near the site, including any material site, with other forces than those of the Contractor. This work may be done with or without a contract. If such work takes place within or next to this project, the Contractor shall cooperate with all other contractors or forces. The Contractor shall carry out work under this project in a way that will minimize interference and delay for all forces involved. The Engineer will resolve any disagreements that may arise among the contractors or the Contractor and the Contracting Agency over the method or order of doing the work. The Engineer's decision in these matters shall be final, as provided in Section 1-05.1.

The coordination of the work shall be taken into account by the Contractor as part of the site investigation in accordance with Section 1-02.4 and any resulting costs shall be incidental and included within the unit bid prices in the contract.

1-05.15 Method of Serving Notices

Any written notice to the Contractor required under these Specifications may be served on the Contractor either personally or by mailing or by delivery to the last post office address known to the Engineer.

All correspondence from the Contractor shall be directed to the Project Engineer.

1-06 CONTROL OF MATERIAL

1-06.1 Approval of Materials Prior To Use

Prior to use, the Contractor shall notify the Engineer of all proposed materials. The Contractor shall use the Qualified Product List or the Request for Approval of Material form.

All equipment, materials, and articles incorporated into the permanent work:

1. Shall be new, unless the special provisions permit otherwise;
2. Shall meet the requirements of the contract and be approved by the Engineer;
3. May be inspected or tested at any time during their preparation and use; and
4. Shall not be used in the work if they become unfit after being previously approved.

1-06.1 (1) Qualified Products List (QPL)

The QPL is a listing of manufactured products that have been evaluated and determined suitable for use in highway construction.

If the Contractor elects to use the QPL, the most current list available at the time the product is proposed for use, shall be used. The QPL submittal shall be prepared by the Contractor in accordance with the instructions in the QPL and submitted to the Engineer prior to use.

The QPL identifies the approved products, the applicable specification section, and the basis for acceptance at the project level. The listing is divided into two categories, “Approved” and “Conditionally Approved”. “Approved” products are denoted with an “A”. Those products may be accepted without additional sampling. “Conditionally Approved” products are denoted with a “CA”. The acceptance and use of these products is based upon additional job sampling and/or documentation. All additional acceptance actions need to be completed prior to the material being incorporated into the work.

The Contractor shall advise the Engineer of the intended items for use from the QPL by reference to the contract bid item.

The use of listed products shall be restricted to the Standard Specification for which they are listed and fulfillment of the acceptance requirement defined in the QPL. Qualified products not conforming to the specifications, not fulfilling the acceptance requirements, or improperly handled or installed, shall be replaced at the Contractor’s expense.

To qualify for continued listing on the QPL, products may be sampled and tested for conformance to the Standard Specifications. The Contracting Agency reserves the right to make revisions to the QPL at any time.

If there is a conflict between the QPL and the contract, the provisions of the contract shall take precedence over the QPL.

1-06.1 (2) Request for Approval of Material (RAM)

The RAM shall be used when the Contractor elects not to use the QPL or the material is not listed in the QPL. The RAM shall be prepared by the Contractor in accordance with the instructions on the form (DOT 350-071) and submitted to the Engineer for approval before the material is incorporated into the work.

Approval of the material does not constitute acceptance of the material for incorporation into the work.

Addition acceptance actions as noted on the RAM need to be completed prior to the materials being incorporated into the work.

When requesting approval of an item that requires fabrication, both the fabricator and the manufacturer of the base material shall be identified on the RAM.

1-06.2 Acceptance of Materials

1-06.2(1) Samples and Tests for Acceptance

The Contractor shall deliver representative samples (from the Contractor, Producer, or Fabricator) to the Engineer without charge before incorporating material into the work. In providing samples, the Contractor shall provide the Engineer with sufficient time and quantities for testing before use. The Engineer may require samples at any time. Samples not taken by or in the presence of the Engineer will not be accepted for test, unless the Engineer permits otherwise.

The Contractor shall designate specific Contractor employees as points of contact for concrete testing and acceptance. Alternates shall be designated to ensure that direct contact is maintained during concrete placement. If designated by the Contractor to the Engineer, the concrete supplier will receive all 28 day concrete strength test results.

The Project Engineer will designate specific Contracting Agency employees as points of contact for concrete testing and acceptance.

The Contractor may observe any of the sampling and testing performed by the Engineer. If the contractor observes a deviation from the specified sampling and testing procedures, the Contractor shall verbally described the deviations observed to the Engineer or designated representative immediately, and shall confirm these observed deviations in writing to the Engineer within 24 hours, referencing the specific procedures and steps. The Engineer will respond in writing within three working days of the receipt of the contractor's written communications.

All field and laboratory materials testing by the Engineer will follow methods described in contract documents, in the Washington State Department of Transportation *Materials Manual*, or in the recognized standards of national organizations. The following provisions will apply when the Contracting Agency uses the specifications or methods from the sources named below:

ASTM — American Society for Testing and Materials. The ASTM designation number refers to this society's latest adopted or tentative standard. The standard or tentative standard in effect on the bid advertising date will apply in each case.

The Contracting Agency will consider any revisions to become effective on December 1 of the year they are adopted.

Copies of any separate ASTM specifications or testing method may be obtained from: the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA.

AASHTO — American Association of State Highway and Transportation Officials. An AASHTO number refers to that organization's currently published (1) "Standard Specifications for Highway Materials and Methods of Sampling and Testing" or any adopted revisions, or (2) "Interim Specifications and Methods of Sampling and Testing Adopted by the AASHTO Subcommittee on Materials."

Any standards, revisions, and interim standards in effect on the bid advertising date will apply. Standards, revisions, and interim standards will be considered as becoming effective on December 1 of the year which they are adopted.

Copies of "Standard Specifications for Highway Materials and Methods of Sampling and Testing" may be obtained from the American Association of State Highway and Transportation Officials, 917 National Press Building, Washington, D.C.

Federal Specification — U.S. Government Federal Stock Catalogue. The specification number refers to the most recent revision adopted by the General Services Administration. Revisions in effect on the bid advertising date will apply.

The Contracting Agency will consider any revision as in effect 60 calendar days after its adoption.

Copies of separate specifications listed in the Federal Stock Catalogue may be obtained at the prices indicated from the Business Service Center, General Services Administration, Regional Office Building, Seventh and D Streets, Washington, D.C.

Other Publications — Any other publication referred to in these Specifications or the special provisions will mean its latest edition. Requirements, and any revisions, in effect on the bid advertising date will apply. The Contracting Agency will consider them as in effect 60 calendar days after publication.

Copies may be obtained from the publishing organizations. For example, copies of standard grading and dressing rules may be obtained from: West Coast Lumber Inspection Bureau in Seattle, Washington or Portland, Oregon, and from the Western Wood Products Association, Portland, Oregon.

1-06.2(2) Statistical Evaluation of Materials for Acceptance

1-06.2(2)A General

Where specified, acceptance sampling and testing will be done by the Contracting Agency and statistically evaluated for acceptance by the provisions of this subsection. All test results for a lot will be analyzed collectively and statistically by the quality level analysis procedures shown at the end of this subsection to determine the total percent of the lot that is within specification limits and to determine an appropriate pay factor. Lots and sublots are defined in the appropriate subsection of these Specifications for the material being statistically evaluated.

Quality level analysis is a statistical procedure for determining the percent compliance of the material with these Specifications. Quality level is the computed percent of material meeting these Specifications and is determined from the arithmetic mean, (X_m), and the sample standard deviation (S), for each constituent of the lot.

Any necessary rounding off of test results or calculations will be accomplished according to the following rule:

1. The final significant digit will not be changed when the succeeding digit is less than 5.
2. The final significant digit will be increased by one when the succeeding digit is 5 or greater.

1-06.2(2)B Financial Incentive

As an incentive to produce superior quality material, a pay factor greater than 1.0000 may be obtained with the maximum pay factor being 1.0500. A lot containing nonspecification material will be accepted provided the Composite Pay Factor reaches the minimum value specified elsewhere. A lot containing nonspecification material which fails to obtain at least the specified minimum Composite Pay Factor will be rejected by the Engineer. The Engineer will take one or more of the following actions when rejected material has been incorporated into the work:

1. Require complete removal and replacement with specification material at no additional cost to the Contracting Agency.

Table 1
Quality Levels
Quality Level Analysis by Standard Deviation Method

P_U or P_L Percent Within Limits for Positive Values of Q_U or Q_L	Upper Quality Index Q_U or Lower Quality Index Q_L														
	n-3	n-4	n-5	n-6	n-7	n-8	n-9	n-10 to n-11	n-12 to n-14	n-15 to n-18	n-19 to n-25	n-26 to n-37	n-38 to n-69	n-70 to n-200	n-201 to n-∞
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99	-	1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97	-	1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95	-	1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93	-	1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81

78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: For negative values of Q_U or Q_L, P_U or P_L is equal to 100 minus the table P_U or P_L. If the value of Q_U or Q_L does not coorespond exactly to a figure in the table, use the next higher value.

Table 2
Pay Factors

Required Quality Level for a Given Sample Size (n) and a Given Pay Factor

Pay Factor	n-3	n-4	n-5	n-6	n-7	n-8	n-9	n-10 to n-11	n-12 to n-14	n-15 to n-18	n-19 to n-25	n-26 to n-37	n-38 to n-69	n-70 to n-200	n-201 to n-∞
1.05	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96	96	97	97	99
1.03	80	85	87	88	89	90	91	91	92	93	93	94	95	96	97
1.02	75	80	83	85	86	87	88	88	89	90	91	92	93	94	95
1.01	71	77	80	82	84	85	85	86	87	88	89	90	91	93	94
1.00	68	74	78	80	81	82	83	84	85	86	87	89	90	91	93
0.99	66	72	75	77	79	80	81	82	83	85	86	87	88	90	92
0.98	64	70	73	75	77	78	79	80	81	83	84	85	87	88	90
0.97	62	68	71	74	75	77	78	78	80	81	83	84	85	87	89
0.96	60	66	69	72	73	75	76	77	78	80	81	83	84	86	88
0.95	59	64	68	70	72	73	74	75	77	78	80	81	83	85	87
0.94	57	63	66	68	70	72	73	74	75	77	78	80	81	83	86
0.93	56	61	65	67	69	70	71	72	74	75	77	78	80	82	84
0.92	55	60	63	65	67	69	70	71	72	74	75	77	79	81	83
0.91	53	58	62	64	66	67	68	69	71	73	74	76	78	80	82
0.90	52	57	60	63	64	66	67	68	70	71	73	75	76	79	81
0.89	51	55	59	61	63	64	66	67	68	70	72	73	75	77	80
0.88	50	54	57	60	62	63	64	65	67	69	70	72	74	76	79

0.87	48	53	56	58	60	62	63	64	66	67	69	71	73	75	78
0.86	47	51	55	57	59	60	62	63	64	66	68	70	72	74	77
0.85	46	50	53	56	58	59	60	61	63	65	67	69	71	73	76
0.84	45	49	52	55	56	58	59	60	62	64	65	67	69	72	75
0.83	44	48	51	53	55	57	58	59	61	63	64	66	68	71	74
0.82	42	46	50	52	54	55	57	58	60	61	63	65	67	70	72
0.81	41	45	48	51	53	54	56	57	58	60	62	64	66	69	71
0.80	40	44	47	50	52	53	54	55	57	59	61	63	65	67	70
0.79	38	43	46	48	50	52	53	54	56	58	60	62	64	66	69
0.78	37	41	45	47	49	51	52	53	55	57	59	61	63	65	68
0.77	36	40	43	46	48	50	51	52	54	56	57	60	62	64	67
0.76	34	39	42	45	47	48	50	51	53	55	56	58	61	63	66
0.75	33	38	41	44	46	47	49	50	51	53	55	57	59	62	65

Reject Quality Levels Less Than Those Specified for a 0.75 Pay Factor

Note: If the computed Quality Level does not correspond exactly to a figure in the table, use the next lower value.

2. At the Contractor's written request, allow corrective work at no additional cost to the Contracting Agency and then an appropriate price reduction that may range from no reduction to no payment.
3. At the Contractor's written request, allow material to remain in place with an appropriate price reduction that may range from a designated percentage reduction to no payment.

Any lot for which at least three samples have been obtained, and all of the test results meet one of the appropriate criteria listed below, will receive at least a 1.000 Composite Pay Factor:

1. All test results are within the allowable limits specified for the item, or
2. All test results are greater than or equal to a minimum specification limit, or
3. All test results are less than or equal to a maximum specification limit.

Computation of the quality level in these instances will be for determining the amount of any bonus which might be warranted.

Lots represented by less than 3 samples or unsampled lots will be exempt from statistical based acceptance.

1-06.2(2)C Removed and Rejected Materials

The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. Any such new material will be sampled, tested, and evaluated for acceptance as a part of the sublot in accordance with this statistical sampling and testing procedure.

The Engineer may reject a sublot which tests show to be defective. Such rejected material shall not be used in the work, and the results of tests run on the rejected material will not be included in the original lot acceptance tests.

1-06.2(2)D Quality Level Analysis

Procedures for determining the quality level and pay factors for a material are as follows:

1. Determine the arithmetic mean, (X_m), of the test results for each specified material constituent:

$$X_m = \frac{\sum x}{n}$$

where: Σ = summation of
x = individual test value
n = total number test values

2. Compute the sample standard deviation, "S", for each constituent:

$$S = \left[\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)} \right]^{\frac{1}{2}}$$

where: $\sum x^2$ = summation of the squares of individual test values

$\left(\sum x\right)^2$ = summation of the individual test values squared

3. Compute the upper quality index, (Q_U), for each constituent:

$$Q_U = \frac{USL - X_m}{S}$$

where, USL (upper specificaiton limit) = target value plus allowable tolerance

4. Compute the lower quality index, (Q_L), for each constituent:

$$Q_L = \frac{X_m - LSL}{S}$$

where: LSL (lower specificaiton limit) = target value minus allowable tolerance

5. For each constituent determine P_U (the percent within the upper specification limit which corresponds to a given Q_U) from Table 1. Note: If a USL is 100.00 percent or is not specified, P_U will be 100.
6. For each constituent determine P_L (the percent within the lower specification limit which corresponds to a given Q_L) from Table 1. Note: If a LSL is not specified, P_L will be 100.
7. For each constituent determine the quality level (the total percent within specification limits):

   Quality Level = (P_U + P_L) - 100

8. Using the quality level from step 7, determine the pay factor (PF_i) from Table 2 for each constituent tested.
9. Determine the Composite Pay Factor (CPF) for each lot.

$$CPF = \frac{f_1\left(\overline{PF_1}\right) + f_2\left(\overline{PF_2}\right) + \cdots + f_i\left(\overline{PF_i}\right)}{\sum_{i=1 \text{ to } j} f_i}$$

where: f_i = price adjustment factor listed in these Specification for the applicable material

j = number of constituents being evaluated

10. Determine an item adjustment factor:

    (item) adjustment factor = CPF - 1

    The (item) adjustment factor will be applied to the unit contract price for specific materials. For specific materials, the (item) adjustment factor will be identified as “Quality Incentive Factor,” “Compliance Incentive Factor,” etc.

1-06.3 Manufacturer's Certificate of Compliance

The Engineer may accept certain materials on the basis of a Manufacturer's Certificate of Compliance as an alternative to material inspection and testing. When a Manufacturer's Certificate of Compliance is authorized by these Specifications or the special provisions, the certification shall be furnished prior to use of the material.

The Contractor may request, in writing, authority from the Engineer to install such materials prior to submitting the required certification; however, no payment will be made for the work in the absence of an acceptable Manufacturer's Certificate of Compliance. The Contracting Agency reserves the right to deny the request for good cause. If for any reason the Contractor has not provided an acceptable Manufacturer's Certificate of Compliance by the physical completion date established by Section 1-08.5, the Contracting Agency will assess the usefulness of the installed material. At the Engineer's discretion, the Contracting Agency will either require replacement of the material by the Contractor at no expense to the contracting Agency or process the final payment as provided by Section 1-09.9 without paying for the materials or any portion of the work performed to install the materials provided on such a basis. The unit contract prices for the work shall be used to determine the amount to be withheld. Where unit contract prices do not exist, as in a lump sum item, the amount to be withheld shall be an equitable adjustment, covering labor, equipment and materials, determined in accordance with Section 1-09.4.

The Manufacturer's Certificate of Compliance must identify the manufacturer, the type and quantity of material being certified, the applicable specifications being affirmed, and the signature of a responsible corporate official of the manufacturer and include supporting mill tests or documents. A Manufacturer's Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate.

All materials used on the basis of a Manufacturer's Certificate of Compliance may be sampled and tested at any time. Any material not conforming to the requirements will be subject to rejection whether in place or not. The Contracting Agency reserves the right to refuse to accept materials on the basis of a Manufacturer's Certificate of Compliance.

1-06.4 Handling and Storing Materials

In storage and handling, the Contractor shall protect materials against damage from careless handling, from exposure to weather, from mixture with foreign matter, and from all other causes. The Engineer will reject and refuse to test materials improperly handled or stored.

The Contractor shall repair, replace, or make good all Contracting Agency-provided materials that are damaged or lost due to the Contractor's operation or while in the Contractor's possession, at no expense to the Contracting Agency.

1-06.5 Vacant

1-06.6 Sieves for Testing

Test sieves shall be made either: (1) of woven wire cloth conforming to AASHTO Designation M 92 or ASTM Designation E 11, or (2) of square-hole, perforated plates conforming to ASTM Designation E 323.

1-07 LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

1-07.1 Laws to be Observed

The Contractor shall always comply with all Federal, State, or local laws, ordinances, and regulations that affect work under the contract. The Contractor shall indemnify, defend, and save harmless the State (including the Commission, the Secretary, and any agents, officers, and employees) against any claims that may arise because the Contractor (or any employee of the Contractor or subcontractor or materialperson) violated a legal requirement.

The Contractor shall be responsible for the safety of his/her workers and shall comply with safety and health standards such as Safety Standards for Construction Work (Chapter 296-155 WAC), General Safety and Health Standards (Chapter 296-24 WAC), General Occupational Health Standard (Chapter 296-62 WAC), and any other appropriate safety and health codes.

U.S. Mine Safety and Health Administration rules apply when the project includes pit or quarry operations. Among other actions, these regulations require the Contractor to notify the nearest Mine Safety and Health subdistrict office (1) of the project before it begins, (2) of the starting date, and (3) of the physical completion date.

Without usurping the authority of other agencies, the Contracting Agency will cooperate with them in their efforts to enforce legal requirements. On noticing any violation of a legal requirement, the Engineer will notify the Contractor in an effort to achieve voluntary compliance. The Engineer may also notify the agency responsible for enforcement if the Engineer deems that action necessary to achieve compliance with legal requirements. The Engineer will also help the enforcing agency obtain Contractor compliance to the extent such help is consistent with the provisions of the contract.

The Contracting Agency will not adjust payment to compensate the Contractor for changes in legal requirements unless those changes are specifically within the scope of RCW 39.04.120. For changes under RCW 39.04.120, the Contracting Agency will compensate the Contractor by negotiated change order as provided in Section 1-04.4.

Under certain conditions, the Contracting Agency will adjust payment to compensate for tax changes. First, the changes shall involve federal or state taxes on materials or fuel used in or consumed for the project. Second, the changes shall increase or decrease Contractor-paid taxes by more than $500. For items in the original contract, the tax change must occur after the bid opening date. For negotiated contracts or items in a supplemental agreement, the tax change must take place after the execution date of the contract or agreement. Within these conditions, the Contracting Agency will adjust compensation by the actual dollar amounts of increase or decrease caused by the tax changes. If the Engineer requests it, the Contractor shall certify in writing that the contract price does not include any extra amount to cover a possible change in taxes.

The Contracting Agency may audit the records of the Contractor as provided in Section 1-09.12, to verify any claim for compensation because of changes in laws or taxes.

1-07.2 State Taxes

The Washington State Department of Revenue has issued special rules on the state sales tax. Sections 1-07.2(1) through 1-07.2(3) are meant to clarify those rules. The Contractor should contact the Financial System Manager, Department of Transportation, Olympia, for answers to questions in this area. The Contracting Agency will not adjust its payment if the Contractor bases a bid on a misunderstood tax liability.

The Contractor shall include all Contractor-paid taxes in the unit bid prices or other contract amounts. In some cases, however, state retail sales tax will not be included. Section 1-07.2(2) describes this exception.

The Contracting Agency will pay the retained percentage only if the Contractor has obtained from the State Department of Revenue a certificate showing that all contract-related taxes have been paid (RCW 60.28.050). The Contracting Agency may deduct from its payments to the Contractor any amount the Contractor may owe the State Department of Revenue, whether the amount owed relates to this contract or not. Any amount so deducted will be paid into the proper State fund.

1-07.2(1) State Sales Tax: Work Performed on City, County, or Federal Owned Land

State Department of Revenue Rule 171 and its related rules apply for this section.

The special provisions of the contract will identify those parts of the project that require work on land owned by:

1. A municipal corporation,
2. A political subdivision of the State, or
3. The United States of America.

For work performed on such land, the Contractor shall include Washington State retail sales taxes in the various unit bid prices or other contract amounts. These retail sales taxes shall include those the Contractor pays on purchases of materials, equipment, and supplies used or consumed in doing the work.

1-07.2(2) State Sales Tax: Work on State-Owned and Private Land

State Department of Revenue Rule 170 and its related rules apply for this section.

The special provisions of the contract will identify those parts of the project that require work on State-owned or private land.

For work performed on State-owned or private land, the Contractor shall collect from the Contracting Agency, retail sales tax on the full contract price. The Contracting Agency will automatically add this sales tax to each payment to the Contractor. For this reason, the Contractor shall not include the retail sales tax in the unit bid prices or in any other contract amount.

However, the Contracting Agency will not add in sales tax the Contractor (prime or subcontractor) pays on the purchase or rental of tools, machinery, equipment, or consumable supplies not integrated into the project. Such sales taxes shall be included in the unit bid prices or in any other contract amount whether the State owns the construction site or not.

1-07.2(3) Services

The Contractor shall not collect retail sales tax from the Contracting Agency on any contract wholly for professional or other services (as defined in State Department of Revenue Rules 138 and 224).

1-07.3 Forest Protection and Merchantable Timber Requirements

1-07.3(1) Forest Fire Prevention

When the work is in or next to State or Federal forests, the Contractor shall know and observe all laws and rules (State or Federal) on fire prevention and sanitation. The Contractor shall ask the local forest supervisor or regional manager to outline requirements for permits, sanitation, fire-fighting equipment, and burning.

The Contractor shall take all reasonable precautions to prevent and suppress forest fires. In case of forest fire, the Contractor shall immediately notify the nearest forest headquarters of its exact site and shall make every effort to suppress it. If needed, the Contractor shall require his/her employees and those of any subcontractor to work under forest officials in fire-control efforts.

1-07.3(2) Merchantable Timber Requirements

When merchantable timber is to be cut, the Contractor shall obtain a permit from the appropriate regional office of the State Department of Natural Resources and comply fully with the State Forest Practices Act.

No person may export from the United States, or sell, trade, exchange, or otherwise convey to any other person for the purpose of export from the United States, timber originating from the project.

The Contractor shall comply with the Forest Resources Conservation and Shortage Relief Amendments Act of 1993, (Public Law 103-45), and the Washington State Log Export Regulations, (WAC 240-15).

1-07.4 Sanitation

The Contractor shall provide employees with all accommodations required by the State Department of Social and Health Services and other agencies. These accommodations shall be kept clean, neat, and sanitized, and shall not create any public nuisance. The Contractor shall keep all camp sites clean, burn or properly dispose of all refuse, and leave each site in a neat and sanitary condition.

1-07.5 Fish and Wildlife and Ecology Regulations

1-07.5(1) General

Throughout the work, the Contractor shall comply with all current rules of the State Departments of Fish and Wildlife, and Ecology. Some, though not all, of these rules are summarized below. Either of these State Departments may, without prejudice to the Contracting Agency, add rules as needed to protect game, fish, or the environment.

1-07.5(2) State Department of Fish and Wildlife

In doing the work, the Contractor shall:

1. Not degrade water in a way that would harm fish. (Criteria: Washington State Water Quality Regulations.)
2. Release any fish stranded by the project into a flowing stream or open water.
3. Replant any stream bank or shoreline area if the project disturbs vegetative cover. Replanted trees, brush, or grasses shall resemble the type and density of surrounding growth, unless the special provisions permit otherwise.
4. Leave, when the work is complete, an open-water channel at the lowest level of any isolated pothole to connect it with the main body of water.
5. Prevent any fish-threatening silt buildup on the bed or bottom of any body of water.
6. Never block stream flow or fish passage.
7. Keep all equipment out of any flowing stream or other body of water, except as may be permitted by the special provisions.

8. Never remove gravel or other bottom material from the high-water-flow channel bed of any stream or from the bottom of any other body of water, except as may be permitted by the special provisions.
9. Dispose of any project debris by removal, burning, or placement above high-water flows.

If the work in (1) through (3) above differs little from what the contract requires, the Contracting Agency will measure and pay for it at unit contract prices. But if contract items do not cover those areas, the Contracting Agency will pay pursuant to Section 1-09.4. Work in (4) through (9) above will be incidental to contract pay items.

1-07.5(3) State Department of Ecology

In doing the work, the Contractor shall:

1. Get a waste discharge permit from the Ecology Department before:
   a. Washing aggregate; and
   b. Discharging water from pit sites or excavations into a ground or surface waterway when the water contains turbidity, silt, or foreign materials.
2. Give the Project Engineer a copy of each waste discharge permit before the work begins.
3. Control drainage and erosion to reduce waterway pollution.
4. Dispose of, in ways that will prevent their entry into State waters, all:
   a. Toxicants (including creosote, oil, cement, concrete, and equipment wash water); and
   b. Debris, overburden, and other waste materials.
5. Notify the Ecology Department immediately should oil, chemicals, or sewage spill into State waters.

1-07.5(4) Air Quality

The Contractor shall comply with all rules of local air pollution authorities. If there are none, air-quality rules of the State Department of Ecology shall govern the work.

The Washington Clean Air Act requires that rock crushing, rock drilling, asphalt batch plants, and concrete plants receive an air quality permit in advance of the operation. The air quality permit process may include additional State Environment Policy Act (SEPA) requirements. Contractors or operators should contact the appropriate air pollution control authority well in advance of intended start-up. The permit process may require up to 30 days.

1-07.6 Permits and Licenses

Contractors shall obtain all required permits and licenses and give any notices these call for.

The Contracting Agency will support the Contractor in efforts to obtain a temporary operating permit in its name if:

1. A local rule or an agency policy prevent issuing the permit to a private firm;
2. The Contractor takes all action to obtain the permit;
3. The permit will serve the public interest;
4. The permit applies only to work under the contract;
5. The Contractor agrees in writing: (a) to comply with all the issuing agency requires, and (b) to hold the Contracting Agency harmless for any work-related liability incurred under the permit; and
6. The permit costs the Contracting Agency nothing.

1-07.7 Load Limits

1-07.7(1) General

While moving equipment or materials on any public highway, the Contractor shall comply with all laws that control traffic or limit loads. The contract neither exempts the Contractor from such laws nor licenses overloads. At the Engineer's request, the Contractor shall provide any facts needed to compute the equipment's weight on the roadway.

When the Contractor moves equipment or materials within the project limits as shown in the Plans, legal load limits shall apply on:

1. Any road open to and in use by public traffic; or
2. Any existing road not scheduled for major reconstruction under the current contract; or
3. Any newly paved road (with final lift in place) built under this contract. The Contractor may haul overloads (not more than 25 percent above load limits) on such roads not open to public traffic if this does not damage completed work. The Contractor shall pay all repair costs of any overload damage.

Elsewhere on the project, the Contractor may operate equipment with only the load-limit restrictions in 1, 2, and 3 in Section 1-07.7(2). The Contractor shall remain responsible, however, for all load-caused damage. All vehicles subject to license on a tonnage basis shall be licensed to maximum legal capacity before operating under these limits.

If necessary and safe to do so, and if the Contractor requests it in writing, the Engineer may approve higher load limits than those in the load-limit restrictions in 1, 2, and 3 in Section 1-07.7(2). The written request shall:

1. Describe loading details;
2. Describe the arrangement, movement, and position of equipment on the structure or over culverts and pipes; and
3. State that the Contractor assumes all risk for damage.

Unit prices shall cover all costs for operating over bridges and culverts. Nothing in this section affects the Contractor's other responsibilities under these Specifications or under public highway laws.

1-07.7(2) Load-Limit Restrictions

1. Structures Designed for Direct Bearing of Live Loads. The gross or maximum load on each vehicle axle shall not exceed the legal load limit by more than 35 percent. No more than one vehicle shall operate over any structure at one time. The Contractor shall immediately remove any dirt, rock, or debris that may gather on the structure's roadway surface.
2. Underpasses and Reinforced Concrete Box Culverts Under Embankments. Loads shall not exceed 10 800 kilograms on a single axle and 7300 kilograms each on tandem axles spaced less than 3 meters apart. These limits are permitted only if the embankment has: (a) been built to specifications, and (b) reached at least 1 meter above the top of the underpass or culvert.

   When the embankment has reached 1.5 meters above the top of the underpass or culvert, the Contractor may increase per-axle loads up to 45 400 kilograms if outside wheel spacing is at least 2.1 meters on axle centers.

3. Pipe Culverts and Sewer Pipes. Loads over pipe culverts and sewer pipes shall not exceed 10 800 kilograms on a single axle and 7300 kilograms each on tandem axles spaced less than 3 meters apart. These limits are permitted only if: (a) the culvert or pipe has been installed and backfilled to specifications, and (b) the embankment has reached at least 0.6 meter above the top limit of pipe compaction, as defined in Design A or Design C.

   When the embankment has reached 1.5 meters above the top limit of pipe compaction, the Contractor may increase per-axle loads up to 45 400 kilograms if outside wheel spacing is at least 2.1 meters on axle centers, except that:

   a. For Class III reinforced concrete pipes, the embankment shall have risen above the top limit of compaction at least: (1) 1.8 meters for Design A work, and (2) 2.1 meters for Design C work.
   b. For Class II reinforced concrete pipes, the maximum load for each axle shall be 36 300 kilograms if outside wheel spacing is at least 2.1 meters on axle centers. In this case, the embankment shall have risen above the top limit of compaction at least: (1) 1.8 meters for Design A work, and (2) 3 meters for Design C work.

1-07.8 High Visibility Apparel

The Contractor shall require all personnel at the work site under their control (including subcontractors and lower tier subcontractors) to comply with the following:

1. To wear reflective vests, except that during daylight hours, clothing of orange, yellow, strong yellow green or fluorescent versions of these colors may be worn in lieu of vests. Flaggers must wear reflective vests and hard hats at all times;
2. During hours of darkness, to wear vests, white coveralls or either high visibility reflective fluorescent lime yellow pants with fluorescent orange strip or reflective fluorescent orange pants with fluorescent lime yellow strip.
3. When rain gear is worn during hours of darkness, it shall be white or yellow;
4. The reflective vests shall always be the outermost garment.

Exceptions to these requirements are: (1) when personnel are out of view of the not exposed to traffic, (2) when personnel are inside a vehicle, or (3) where it is obvious that such apparel is not needed for the employees safety from traffic.

Reflective vests shall be high visibility lime-yellow in base color with orange-red trim and 3M silver Scotchlite reflective material (or equivalent) or orange-red base color with lime-yellow reflective stripe. Vests shall have 230 or more square inches of reflective trim as measured on a medium best. The 3M type 6187 (or equivalent) 2” wide lime-yellow reflective stripe can be used as the lime-yellow trim on a red-orange vest. All components to these garments must be visible in 360 degrees, from all angles and the reflective material visible at a minimum of 1000 feet.

Reflective vests, hard hats, white coveralls, rain gear, and other apparel shall be furnished and maintained in a neat, clean, and presentable condition at no expense to the Contracting Agency.

1-07.9 Wages

1-07.9(1) General

This contract is subject to the minimum wage requirements of RCW 39.12 and to RCW 49.28 (as amended or supplemented). On Federal-aid projects, Federal wage laws and rules also apply. The hourly minimum rates for wages and fringe benefits are listed in the contract

provisions. When Federal wage and fringe benefit rates are listed, the rates match those identified by the U.S. Department of Labor's "Decision Number" shown in the contract provisions.

The Contractor, any subcontractor, and all individuals or firms required by RCW 39.12, WAC 296-127, or the Federal Davis-Bacon and Related Acts (DBRA) to pay minimum prevailing wages, shall not pay any worker less than the minimum hourly wage rates and fringe benefits required by RCW 39.12 or the DBRA. Higher wages and benefits may be paid.

By including the hourly minimum rates for wages and fringe benefits in the contract provisions, the Contracting Agency does not imply that the Contractor will find labor available at those rates. The Contractor shall be responsible for any amounts above the minimums that will actually have to be paid. The Contractor shall bear the cost of paying wages above those shown in the contract provisions.

When the project is subject to both State and Federal hourly minimum rates for wages and fringe benefits and when the two rates differ for similar kinds of labor, the Contractor shall not pay less than the higher rate unless the State rates are specifically preempted by Federal law. When the project involves both highway work and building work, the contract provisions may list a Federal wage and fringe benefit rate for the highway work and a separate Federal wage and fringe benefit rate for the building work. The area in which the worker is physically employed shall determine which Federal wage and fringe benefit rate shall be used to compare against the State wage and fringe benefit rate.

If employing labor in a class not listed in the contract provisions, the Contractor shall request a determination of the correct wage rate for that class and locality from the Industrial Statistician, Washington State Department of Labor and Industries (State L&I), and from the U.S. Secretary of Labor on Federal-aid projects. The Contractor shall provide a copy of these determinations to the Engineer.

The Contractor shall ensure that any firm (Supplier, Manufacturer, or Fabricator) that falls under the provisions of RCW 39.12 because of the definition "Contractor" in WAC 296-127-010, complies with all the requirements of RCW 39.12.

The Contractor shall be responsible for compliance with the requirements of the DBRA and RCW 39.12 by all firms (Subcontractors, Lower Tier Subcontractors, Suppliers, Manufacturers, or Fabricators) engaged in any part of the work necessary to complete this contract. Therefore, should a violation of this subsection occur by any firm that is providing work or materials for completion of this contract whether directly or indirectly responsible to the Contractor, the Contracting Agency will take action against the Contractor, as provided by the provisions of the contract, to achieve compliance, including but not limited to, withholding payment on the contract until compliance is achieved.

In the event the Contracting Agency has an error (omissions are not errors) in the listing of the hourly minimum rates for wages and fringe benefits in the contract provisions, the Contractor, any subcontractor, any lower tier subcontractor, or any other firm that is required to pay prevailing wages, shall be required to pay the rates as determined to be correct by State L&I (or by the U.S. Department of Labor when that agency sets the rates). A change order will be prepared to ensure that this occurs. The Contracting Agency will reimburse the Contractor for the actual cost to pay the difference between the correct rates and the rates included in the contract provisions, subject to the following conditions:

1. The affected firm relied upon the rates included in the contract provisions to prepare its bid and certifies that it did so;

2. The allowable amount of reimbursement will be the difference between the rates listed and rates later determined to be correct plus only appropriate payroll markup the employer must pay, such as, social security and other payments the employer must make to the Federal or State Government;
3. The allowable amount of reimbursement may also include some overhead cost, such as, the cost for bond, insurance, and making supplemental payrolls and new checks to the employees because of underpayment for previously performed work; and
4. Profit will not be an allowable markup.

Firms that anticipated, when they prepared their bids, paying a rate equal to, or higher than, the correct rate as finally determined will not be eligible for reimbursement.

1-07.9(2) Posting Notices

In a location acceptable to State L&I, the Contractor shall ensure the following is posted:

1. One copy of the approved "Statement of Intent to Pay Prevailing Wages" for the Contractor, each subcontractor, each lower tier subcontractor, and any other firm (Supplier, Manufacturer, or Fabricator) that falls under the provisions of RCW 39.12 because of the definition of "Contractor" in WAC 296-127-010;
2. One copy of the prevailing wage rates for the project;
3. The address and telephone number of the Industrial Statistician for State L&I (along with notice that complaints or questions about wage rates may be directed there); and
4. FHWA 1495/1495A "Wage Rate Information" poster if the project is funded with Federal-aid.

1-07.9(3) Apprentices

If employing apprentices, the Contractor shall submit to the Engineer written evidence showing:

1. Each apprentice is enrolled in a program approved by the Washington State Apprenticeship and Training Council;
2. The progression schedule for each apprentice; and
3. The established apprentice-journey level ratios and wage rates in the project locality upon which the Contractor will base such ratios and rates under the contract. Any worker for whom an apprenticeship agreement has not been registered and approved by the Washington State Apprenticeship and Training Council shall be paid at the prevailing hourly journey level rate as provided in RCW 39.12.021.

1-07.9(4) Disputes

If labor and management cannot agree in a dispute over the proper prevailing wage rates, the Contractor shall refer the matter to the Director of State L&I (or to the U.S. Secretary of Labor when that agency sets the rates). The Director's (or Secretary's) decision shall be final, conclusive, and binding on all parties.

1-07.9(5) Required Documents

On forms provided by the Industrial Statistician of State L&I, the Contractor shall submit to the Engineer the following for itself and for each firm covered under RCW 39.12 that provided work and materials for the contract:

1. A copy of an approved "Statement of Intent to Pay Prevailing Wages" State L&I's form number F700-029-000. The Contracting Agency will make no payment under this contract for the work performed until this statement has been approved by State L&I and a copy of the approved form has been submitted to the Engineer.
2. A copy of an approved "Affidavit of Prevailing Wages Paid," State L&I's form number F700-007-000. The Contracting Agency will not release to the Contractor any funds retained under RCW 60.28.011 until all of the "Affidavit of Prevailing Wages Paid" forms have been approved by State L&I and a copy of all the approved forms have been submitted to the Engineer.

The Contractor shall be responsible for requesting these forms from State L&I and for paying any approval fees required by State L&I.

Certified payrolls are required to be submitted by the Contractor to the Engineer, for the Contractor and all subcontractors or lower tier subcontractors, on all Federal-aid projects and, when requested in writing by the Engineer, on projects funded with only Contracting Agency funds. If these payrolls are not supplied within ten calendar days of the end of the preceding weekly payroll period for Federal-aid projects or within ten calendar days from the date of the written request on projects with only Contracting Agency funds, any or all payments may be withheld until compliance is achieved. Also, failure to provide these payrolls could result in other sanctions as provided by State laws (RCW 39.12.050) and/or Federal regulations (29 CFR 5.12). All certified payrolls shall be complete and explicit. Employee labor descriptions used on certified payrolls shall coincide exactly with the labor descriptions listed on the minimum wage schedule in the contract unless the Engineer approves an alternate method to identify labor used by the Contractor to compare with the labor listed in the contract provisions. When an apprentice is shown on the certified payroll at a rate less than the minimum prevailing journey wage rate, the apprenticeship registration number for that employee from the State Apprenticeship and Training Council shall be shown along with the correct employee classification code.

1-07.9(6) Audits

The Contracting Agency may inspect or audit the Contractor's wage and payroll records as provided in Section 1-09.12.

1-07.10 Worker's Benefits

The Contractor shall make all payments required for unemployment compensation under Title 50 RCW and for industrial insurance and medical aid required under Title 51 RCW. If any payment required by Title 50 or Title 51 is not made when due, the Contracting Agency may retain such payments from any money due the Contractor and pay the same into the appropriate fund. Such payment will be made only after giving the Contractor 15 days prior written notice of the Contracting Agency's intent to disburse the funds to the Washington State Department of Labor and Industries or Washington State Employment Security Department as applicable. The payment will be made upon expiration of the 15 calendar day period if no legal action has been commenced to resolve the validity of the claim. If legal action is instituted to determine the validity of the claim prior to the expiration of the 15-day period, the Contracting Agency will hold the funds until determination of the action or written settlement agreement of the appropriate parties.

For work on or adjacent to water, the Contractor shall make the determination as to whether workers are to be covered under the Longshoremen's and Harbor Worker's Compensation Act administered by the U.S. Department of Labor, or the State Industrial Insurance coverage administered by the Washington State Department of Labor and Industries.

The Contractor shall include in the various items in the bid proposal all costs for payment of unemployment compensation and for providing either or both of the insurance coverages. The Contractor will not be entitled to any additional payment for: (1) failure to include such costs, or (2) determinations made by the U.S. Department of Labor or the Washington State Department of Labor and Industries regarding the insurance coverage.

The Public Works Contract Division of the Washington State Department of Labor and Industries will provide the Contractor with applicable industrial insurance and medical aid classification and premium rates. After physical completion of the project, the Contractor shall submit a "Request for Release" to the Washington State Department of Labor and Industries on the form they provide. The "Request for Release" form is for the purpose of obtaining a release with respect to the payments of industrial insurance and medical aid premiums.

1-07.11 Requirements For Non-discrimination

1-07.11 (1) General Application

Discrimination in all phases of contracted employment, contracting activities and training is prohibited by Title VI of the Civil Rights Act of 1964, Section 162(a) of the Federal-Aid Highway Act of 1973, Section 504 of the Rehabilitation Act of 1973, the Age Discrimination Act of 1975, the Justice System Improvement Act of 1979, the American with Disabilities Act of 1990, the Civil Rights Restoration Act of 1987, 49 CFR Part 21, RCW 49.60 and other related laws and statutes. The referenced legal citations establish the minimum requirements for affirmative action efforts and define the basic non-discrimination provisions as required by this section of these Standard Specifications.

1-07.11 (2) Contractual Requirements

1. The Contractor shall not discriminate against any employee or applicant for contracted employment because of race, creed, color, national origin, sex, age, marital status, or the presence of any physical, sensory or mental disability.
2. The Contractor shall, in all solicitations or advertisements for employees, state that all qualified applicants will be considered for employment, without regard to race, creed, color, national origin, sex, age, marital status, or the presence of any physical, sensory, or mental disability.
3. The Contractor shall insert the following notification in all solicitations for bids for work or material subject to federal laws and regulations and made in connection with all program and activities and, in adapted form in all proposals for negotiated agreements:

   The Contractor in accordance to Title VI of the Civil Rights Act of 1964, 78 Stat.252, 42 U.S. Code 2000d to 2000d-4 ,and Title 49 Code of Federal Regulations, Part 21, hereby notifies all bidders that it will affirmatively insure that in any contract entered into pursuant to this advertisement, minority business enterprises will be afforded full opportunity to submit bids in response to this invitation and will not de discriminated against on the grounds of race, color national origin and sex in consideration for an award.

4. The Contractor shall make decisions with regard to selection and retention of sub Contractors, procurement of materials and equipment and similar actions related to the contract without regard to race, creed, color, national origin, sex, age, marital status, or the presence of any physical, sensory, or mental disability.
5. The Contractor shall send to each labor union, employment agency, or representative of workers with which the Contractor has a collective bargaining agreement or other contract or understanding, a notice advising the labor union, employment agency or worker's representative, of the Contractor's commitments under this contract with regard to non-discrimination.
6. The Contractor shall permit access to its books, records and accounts by the Contracting Agency for the purpose of investigating to ascertain compliance with these specifications. In the event that information required of a Contractor is in the possession of another who fails or refuses to furnish this information, the Contractor shall describe, in writing, what efforts were made to obtain the information.
7. The Contractor shall maintain records with the name and address of each minority/female worker referred to the Contractor and what action was taken with respect to the referred worker.
8. The Contractor shall notify the Contracting Agency whenever the union with which the Contractor has a collective bargaining agreement has impeded the Contractor's efforts to effect minority/female workforce utilization. This being the case, the Contractor shall show what relief they have sought under such collective bargaining agreements.
9. The Contractor is encouraged to participate in Contracting Agency and Washington State Human Rights Commission approved program(s) designed to train craft-workers for the construction trades.

1-07.11(3) Equal Employment Opportunity Officer

The Contractor shall officially designate and make known to the Engineer during the preconstruction meetings and discussions the firm's Equal Employment Opportunity Officer (hereinafter referred to as the EEO Officer). The EEO Officer will also be responsible for making him/herself known to each of the Contractor's employees. The EEO Officer must possess the responsibility, authority, and capability for administering and promoting an active and effective Contractor program of equal employment opportunity.

1-07.11(4) Dissemination of Policy

1-07.11(4)A Supervisory Personnel

All members of the Contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, shall be made fully cognizant of, and shall implement the Contractor's equal employment opportunity policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To ensure that the above agreement will be met, the following actions shall be taken as a minimum:

1. EEO Meetings. Periodic meetings of supervisory and personnel office employees shall be conducted before the start of work and then not less often than once every 6 months, at which time the Contractor's equal employment opportunity policy and its implementation shall be reviewed and explained. The meetings shall be conducted by the EEO Officer or other knowledgeable company official.

2. EEO Indoctrination. All new supervisory or personnel office employees shall be given a thorough indoctrination by the EEO Officer or other knowledgeable company official covering all major aspects of the Contractor's equal employment opportunity obligations within 30 days following their reporting for duty with the Contractor.
3. Internal EEO Procedures. All personnel who are engaged in direct recruitment for the project shall be instructed by the EEO Officer or appropriate company official in the Contractor's procedures for locating and hiring minority group and female employees.

1-07.11(4)B Employees, Applicants, and Potential Employees

In order to make the Contractor's equal employment opportunity policy known to all employees, prospective employees, and potential sources of employees, e.g., schools, employment agencies, labor unions (where appropriate), college placement officers, community organizations, etc., the Contractor shall take the following actions:

1. Notices and Posters. Notices and posters setting forth the Contractor's equal employment opportunity policy shall be placed in areas readily accessible to employees, applicants for employment, and potential employees.
2. EEO Indoctrination. The Contractor's equal employment opportunity policy and the procedures to implement such policy shall be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

1-07.11(5) Sanctions

In the event of the Contractor is found in non-compliance with the provisions of Section 1-07.11, the Contracting Agency may impose such contract sanctions as it or the Federal Highway Administration may determine necessary to gain compliance including, but not limited to:

1. Progress payment requests may not be honored until the non-compliance is remedied to the satisfaction of the Contracting Agency.
2. The contract may be suspended, in whole or in part, until such time as the Contractor is determined to be in compliance by the Contracting Agency.
3. The Contractor's pre-qualification may be suspended or revoked pursuant to WAC468-16. The Contracting Agency may refer the matter to the Federal Highway Administration (FHWA) for possible federal sanctions.
4. The contract may be terminated

1-07.11(6) Incorporation of Provisions

The Contractor shall include the provisions of Section 1-07.11 (2) Contractual Requirements (1) through (4) and the Section 1-07.11 (3) Sanctions in every subcontract including procurement of materials and leases of equipment. The Contractor shall take such action or enforce sanctions with respect to a subcontractor or supplier as the Contracting Agency or the FHWA may direct as a means of enforcing such provisions. In the event a Contractor becomes involved in litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the Contracting Agency enter into such litigation to protect their interests and the Contracting Agency may request the federal government to enter into such litigation to protect the interests of the United States.

1-07.11(7) Vacant

1-07.11(8) Vacant

1-07.11(9) Subcontracting, Procurement of Materials, and Leasing of Equipment

Nondiscrimination — The Contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age, or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment.

Solicitation and Utilization — The Contractor shall use their best effort to solicit bids from, and to utilize, disadvantaged, minority, and women subcontractors, or subcontractors with meaningful minority and women representation among their employees.

Subcontractor EEO Obligations — The Contractor shall notify all potential subcontractors and suppliers of the EEO obligations required by the contract. The Contractor shall use their efforts to ensure subcontractors compliance with their equal employment opportunity obligations.

1-07.11(10) Records and Reports

1-07.11(10)A General

The Contractor shall keep such records as are necessary to determine compliance with the Contractor's equal employment opportunity obligations. The records kept by the Contractor shall be designated to indicate:

1. Work Force Data. The number of minority and nonminority group members and women employed in each work classification on the project.
2. Good Faith Efforts — Unions. The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women (applicable only to contractors who rely in whole or in part on unions as a source of their work force).
3. Good Faith Efforts — Recruitment. The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees.
4. Subcontracting. The progress and efforts being made in securing the services of disadvantaged, minority, and women subcontractors or subcontractors with meaningful minority and female representation among their employees.

1-07.11(10)B Required Records and Retention

All records must be retained for a period of three years following completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the State Department of Transportation, and on Federal-aid projects, the Federal Highway Administration.

On Federal-aid contracts only, the Contractor/Subcontractor shall submit to the Project Engineer a completed FHWA 1391 by August 25. The report must reflect the Contractor/Subcontractor's total employment on all Federal-aid highway projects with the Contracting Agency as of July 31. The staffing figures to be reported should represent the project work force on board in all or any part of the last payroll period preceding the end of July. For multiyear projects, a report is required to be submitted each year throughout the duration of the contract.

All Contractors/Subcontractors having contracts of $100,000 or more that are Federally funded shall submit WSDOT Form 820-010 to the Project Engineer by the fifth of the month during the term of the contract. The Contractors/Subcontractor shall maintain this information for all Contracting Agency funded projects, and those Federally funded projects under $100,000.

Failure to submit the required reports by their due dates may result in the withholding of progress estimate payments.

1-07.12 Federal Agency Inspection

Federal laws, rules, and regulations shall be observed by the Contractor on Federal-aid projects. This work is subject to inspection by the appropriate Federal agency. The Contractor shall cooperate with the Federal agencies in these inspections. These inspections shall not make the Federal Government a party to the contract and shall not constitute an interference with the rights of the Contracting Agency or the Contractor.

1-07.13 Contractor's Responsibility for Work

1-07.13(1) General

All work and material for the contract, including any change order work, shall be at the sole risk of the Contractor until the entire improvement has been completed as determined by the Engineer, except as provided in this section.

The Contractor shall rebuild, repair, restore, and make good all damages to any portion of the permanent or temporary work occurring before the physical completion date and shall bear all the expense to do so, except damage to the permanent work caused by: (a) acts of God, such as earthquake, floods, or other cataclysmic phenomenon of nature, or (b) acts of the public enemy or of governmental authorities; or (c) slides in cases where Section 2-03.3(11) is applicable; Provided, however, that these exceptions shall not apply should damages result from the Contractor's failure to take reasonable precautions or to exercise sound engineering and construction practices in conducting the work.

If the performance of the work is delayed as a result of damage by others, an extension of time will be evaluated in accordance with Section 1-08.8.

Nothing contained in this section shall be construed as relieving the Contractor of responsibility for, or damage resulting from, the Contractor's operations or negligence, nor shall the Contractor be relieved from full responsibility for making good any defective work or materials as provided for under Section 1-05.

1-07.13(2) Relief of Responsibility for Completed Work

Upon written request, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work, as described below, which have been completed in all respects in accordance with the requirements of the contract. If the Engineer provides written approval, the Contractor will be relieved of the responsibility for damage to said completed portions of the work resulting from use by public traffic or from the action of the elements or from any other cause, but not from damage resulting from the Contractor's operations or negligence.

Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:

1. The completion of 0.5 kilometer of roadway or 0.5 kilometer of one roadway of a divided highway or a frontage road including the traveled way, shoulders, drainage control facilities, planned roadway protection work, lighting, and any required traffic control and access facilities.
2. A bridge or other structure of major importance.
3. A complete unit of a traffic control signal system or of a highway lighting system.
4. A complete unit of permanent highway protection work.
5. A building which is functionally complete and open to the public.
6. Any contract proposal item.

1-07.13(3) Relief of Responsibility for Damage by Public Traffic

When it is necessary for public traffic to utilize a highway facility during construction, the Contractor will be relieved of responsibility for damages to permanent work by public traffic under the following circumstances:

1. The work is in accordance with the contract plans or approved stage construction plans,
2. The work is on a section of roadway required by the contract to be opened to public traffic, and
3. The traffic control is in accordance with the approved traffic control plans.

If traffic is relocated to another section of roadway, the Contractor shall resume responsibility for the work until such time as the section of roadway is again open to public traffic or the Contractor submits a written request for work that is completed to a point where relief can be granted in accordance with Section 1-07.13(2).

1-07.13(4) Repair of Damage

The Contractor shall promptly repair all damage to either temporary or permanent work as directed by the Engineer. For damage qualifying for relief under Sections 1-07.13(1), 1-07.13(2), or 1-07.13(3), payment will be made in accordance with Section 1-04.4. Payment will be limited to repair of damaged work only. No payment will be made for delay or disruption to the work.

The Engineer may elect to accomplish repair by Contracting Agency forces or other means.

1-07.14 Responsibility for Damage

The State, Commission, Secretary, and all officers and employees of the State, including but not limited to those of the Department, will not be responsible in any manner: for any loss or damage that may happen to the work or any part; for any loss of material or damage to any of the materials or other things used or employed in the performance of work; for injury to or death of any persons, either workers or the public; or for damage to the public for any cause which might have been prevented by the Contractor, or the workers, or anyone employed by the Contractor.

The Contractor shall be responsible for any liability imposed by law for injuries to, or the death of, any persons or damages to property resulting from any cause whatsoever during the performance of the work, or before final acceptance.

Subject to the limitations in this section, the Contractor shall indemnify, defend, and save harmless the State, Commission, Secretary, and all officers and employees of the State from all claims, suits, or actions brought for injuries to, or death of, any persons or damages resulting from construction of the work or in consequence of any negligence regarding the work, the use of any improper materials in the work, caused in whole or in part by any act

or omission by the Contractor or the agents or employees of the Contractor during performance or at any time before final acceptance. In addition to any remedy authorized by law, the State may retain so much of the money due the Contractor as deemed necessary by the Engineer to ensure indemnification until disposition has been made of such suits or claims.

Subject to the limitations in this section, the Contractor shall indemnify, defend, and save harmless any county, city, or region, its officers, and employees connected with the work, within the limits of which county, city, or region the work is being performed, all in the same manner and to the same extent as provided above for the protection of the State, its officers and employees, provided that no retention of money due the Contractor be made by the State except as provided in RCW 60.28, pending disposition of suits or claims for damages brought against the county, city, or district.

The Contractor will not be required to indemnify, defend, or save harmless the indemnitee as provided in the preceding paragraphs of this section if the claim, suit, or action for injuries, death, or damages is caused by the sole negligence of the indemnitee. Where such claims, suits, or actions result from the concurrent negligence of (a) the indemnitee or the indemnitee's agents or employees and (b) the Contractor or the Contractor's agent or employees, the indemnity provisions provided in the preceding paragraphs of this section shall be valid and enforceable only to the extent of the Contractor's negligence or the negligence of its agents and employees.

The Contractor shall bear sole responsibility for damage to completed portions of the project and to property located off the project caused by erosion, siltation, run-off, or other related items during the construction of the project. The Contractor shall also bear sole responsibility for any pollution of rivers, streams, ground water, or other waters which may occur as a result of construction operations.

The Contractor shall exercise all necessary precautions throughout the life of the project to prevent pollution, erosion, siltation, and damage to property.

1-07.15 Temporary Water Pollution/Erosion Control

This work consists of temporary measures shown in the plans, specified in the special provisions, proposed by the Contractor and approved by the Engineer, or ordered by the Engineer as work proceeds. This work is intended to prevent, control, and stop water pollution or erosion within the project, thereby protecting the work, nearby land, streams, and other bodies of water.

Controlling pollution, erosion, run-off, and related damage may require the Contractor to perform temporary work items including but not limited to:

1. Providing ditches, berms, culverts, and other measures to control surface water;
2. Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows;
3. Controlling underground water found during construction; or
4. Covering or otherwise protecting slopes until permanent erosion-control measures are working.

Before any work begins, the Contractor shall obtain the Engineer's approval on a plan for temporary water pollution/erosion control. The plan shall show the schedule for all erosion-control work, whether permanent as required by the contract or temporary as proposed by the Contractor. The plan shall cover all areas the Contractor's work may affect inside and outside the limits of the project (including all Contracting Agency-provided sources, disposal sites, and haul roads, and all nearby land, streams, and other bodies of water). Before this plan has been approved, the Contractor shall do no clearing and

grubbing or earthwork unless the Engineer approves in writing. The Contractor shall revise and update the plan whenever the Engineer so requests in writing.

The Contractor shall allow at least five working days for the Engineer's review of any original or revised plan. Failure to approve all or part of any such plan shall not make the Contracting Agency liable to the Contractor for any work delays.

To the degree possible, the Contractor shall coordinate this temporary work with permanent drainage and erosion control work the contract requires.

If the Engineer, under Section 1-08.6, orders the work suspended for an extended time, the Contractor shall, before the Contracting Agency assumes maintenance responsibility, make every effort to control erosion, pollution, and run-off during shutdown. Section 1-08.7 describes the Contracting Agency's responsibility in such cases.

If natural elements rut or erode the slope, the Contractor shall restore and repair the damage, with the eroded material where possible, and clean up any remaining material in ditches and culverts. If the Engineer orders replacement with more or other materials, unit contract prices will cover the quantities needed.

If the Engineer anticipates water pollution or erosion, the Contractor shall schedule the work so that grading and permanent erosion control immediately follow clearing and grubbing. If conditions prevent such scheduling, the Engineer will require temporary control measures between work stages.

The Engineer will not permit the area of excavation, borrow, and embankment work to exceed the Contractor's ability to meet the schedule for finish grading, mulching, seeding, and other permanent erosion control work.

Clearing and grubbing, excavation, borrow, or fill within the right of way shall never expose more than 70 000 square meters of erodible earth, unless the Engineer approves otherwise. The Engineer may increase or decrease this 70 000-square-meter limit in light of project conditions.

The Engineer may require temporary control measures if it appears pollution or erosion may result from weather, the nature of the materials, or progress on the work. The Engineer may also require permanent erosion control work to be done with or immediately after grading.

When temporary control devices are no longer needed, the Contractor shall remove them and finish the areas they occupied as the Engineer directs.

Nothing in this section shall relieve the Contractor from complying with other contract requirements.

If done according to the approved plan or the Engineer's orders, temporary water pollution/erosion control work will be measured and paid pursuant to Section 1-09.6.

The Contractor shall bear full responsibility for temporary water pollution control in all sources of material, disposal sites, and haul roads the Contractor provides. All costs for this work shall be included in the various unit prices for materials obtained from or hauled to Contractor-provided sites.

Erosion control items named in the contract shall be considered permanent control measures and paid for at unit contract prices.

1-07.16 Protection and Restoration of Property

1-07.16(1) Private/Public Property

The Contractor shall protect private or public property on or in the vicinity of the work site. The Contractor shall ensure that it is not removed, damaged, destroyed, or prevented from being used unless the contract so specifies.

Property includes land, utilities, trees, landscaping, improvements legally on the right-of-way, markers, monuments, buildings, structures, pipe, conduit, sewer or water lines, signs, and other property of all description whether shown on the plans or not.

If the Engineer requests in writing, or if otherwise necessary, the Contractor shall install protection, acceptable to the Engineer, for property such as that listed in the previous paragraph. The Contractor is responsible for locating all property that is subject to damage by the construction operation.

If the Contractor (or agents/employees of the Contractor) damage, destroy, or interfere with the use of such property, the Contractor shall restore it to original condition. The Contractor shall also halt any interference with the property's use. If the Contractor refuses or does not respond immediately, the Engineer may have such property restored by other means and subtract the cost from money that will be or is due the Contractor.

1-07.16(2) Vegetation Protection and Restoration

Existing vegetation, where shown in the Plans or designated by the Engineer, shall be saved and protected through the life of the contract. The Engineer will designate the vegetation to be saved and protected by a site preservation line and/or individual flagging.

Damage which may require replacement of vegetation includes bark stripping, broken branches, exposed root systems, cut root systems, poisoned root systems, compaction of surface soil and roots, puncture wounds, drastic reduction of surface roots or leaf canopy, changes in grade greater than 150 millimeters, or any other changes to the location that may jeopardize the survival or health of the vegetation to be preserved.

When large roots of trees designated to be saved are exposed by the Contractor's operation, they shall be wrapped with heavy burlap for protection and to prevent excessive drying. The burlap shall be kept moist and securely fastened until the roots are covered to finish grade. All burlap and fastening material shall be removed from the roots before covering. All roots 25 millimeters or smaller in diameter, which are damaged, shall be pruned with a sharp saw or pruning shear. Damaged, torn, or ripped bark shall be removed as directed by the Engineer.

If due to, or for any reason related to the Contractor's operation, any tree, shrub, ground cover or herbaceous vegetation designated to be saved is destroyed, disfigured, or damaged to the extent that continued life is questionable as determined by the Engineer, it shall be removed by the Contractor at the direction of the Engineer.

The Contractor will be assessed damages equal to triple the value of the vegetation as determined in the *Guide for Plant Appraisal*, Eighth Edition, published by the International Society of Arboriculture or the estimated cost of restoration with a similar species. Shrub, ground cover, and herbaceous plant values will be determined using the Cost of Cure Method. Any damage so assessed will be deducted from the monies due or that may become due the Contractor.

1-07.16(3) Fences, Mailboxes, Incidentals

The Contractor shall maintain any temporary fencing to preserve livestock, crops, or property when working through or adjacent to private property. The Contractor is liable for all damages resulting from not complying with this requirement.

The usefulness of existing mail or paper boxes shall not be impaired. If the contract anticipates removing and reinstalling the mail or paper boxes, the provisions of Section 8-18 will apply. If the mail or paper boxes are rendered useless solely by acts (or inaction) of the Contractor or for the convenience of the Contractor, the work shall be performed as provided in Section 8-18 at the Contractor's expense.

1-07.16(4) Payment

All costs to comply with this section and for the protection and repair specified in this section are incidental to the contract and are the responsibility of the Contractor. The Contractor shall include all related costs in the unit bid prices of the contract.

1-07.17 Utilities and Similar Facilities

The Contractor shall protect all private and public utilities from damage resulting from the work. Among others, these utilities include: telephone, telegraph, and power lines; sewer and water lines; railroad tracks and equipment; and highway lighting and signing systems.

In accordance with RCW 19.122, the Contractor shall call the utilities underground location center for field location of utilities. If no locator service is available for the area, notice shall be provided individually to those owners of utilities known to, or suspected of, having underground facilities within the area of the proposed excavation.

If the work requires removing or relocating a utility, the contract will assign the task to the Contractor or the utility owner. When this task is assigned to the utility owner and work is not complete before the Contractor begins work, the Contractor shall immediately notify the Engineer in writing.

Any authorized agent of the Contracting Agency or utility owners may enter the highway right-of-way to repair, rearrange, alter, or connect their equipment. The Contractor shall cooperate with such efforts and shall avoid creating delays or hindrances to those doing the work. As needed, the Contractor shall arrange to coordinate work schedules.

To ease or streamline the work, the Contractor may desire to ask utility owners to move, remove, or alter their equipment in ways other than those listed in the plans or special provisions. The Contractor shall make the arrangements and pay all costs that arise from them.

In some cases, the Plans or special provisions may not show all underground facilities. If the work requires these to be moved, the Engineer will provide for other forces to move them or issue a written change order requiring the Contractor to do so as provided in Section 1-04.4.

All costs required to protect public and private utilities as provided in this section shall be at the Contractor's expense. When others delay the work through late removal or relocation of any utility or similar facility, the Contractor's loss of time will be adjusted by extending contract time in keeping with Section 1-08.8.

If the contract provides notice that utilities will be adjusted, relocated, replaced, or constructed during the prosecution of the work, the Contractor shall carry out the work in a way that will minimize interference and delay for all forces involved. Any costs resulting from the coordination and prosecution of the work regarding utility adjustment, relocation, replacement, or construction shall be at the Contractor's expense as provided in Section 1-05.14.

1-07.18 Public Liability and Property Damage Insurance

The contractor shall obtain and keep in force during the term of the contract and until 30 days after the Physical Completion date, unless otherwise indicated below, the following insurance with companies or through sources approved by the State Insurance commissioner pursuant to Chapter 48.05, RCW.

1. Owners and Contractors Protective Insurance providing bodily injury and property damage liability with limits of $1,000,000 per occurrence and in the aggregate, written on Insurance Services Office (ISO) form CG0009 with Washington State Department of Transportation Amendatory Endorsement No. CG 29 08 or another form providing identical coverage.
2. Commercial General Liability Insurance written under ISO Form CG0001 or its equivalent with minimum limits of $1,000,000 each occurrence and $2,000,000 in the aggregate for each policy year. Products and completed operations coverage shall be provided for a period of one year following final acceptance of the work.
3. Commercial Automobile Liability Insurance providing bodily injury and property damage liability coverage for all owned and nonowned vehicles assigned to or used in the performance of the work for a combined single limit of not less than $1,000,000 each occurrence with the State named as an additional insured in connection with the Contractor's Performance of the contract.

Prior to contract execution, the Contractor shall file with the Department of Transportation, Contract Payment Section, P.O. Box 47420, Olympia, WA 98504-7420, ACORD Form Certificates of Insurance evidencing the minimum insurance coverages required under these specifications.

All insurance policies and Certificates of Insurance shall include a requirement providing for a minimum of 45 days prior written notice to the Contracting Agency of any cancellation or reduction of coverage.

Failure on the part of the Contractor to maintain the insurance as required shall constitute a material breach of contract upon which the Contracting Agency may, after giving five working days notice to the Contractor to correct the breach, immediately terminate the contract or, at its discretion, procure or renew such insurance and pay any and all premiums in connection therewith, with any sums so expended to be repaid to the Contracting Agency on demand, or at the sole discretion of the Contracting Agency, off set against funds due the Contractor from the Contracting Agency.

All costs for insurance shall be considered incidental to and included in the unit contract prices and no additional payment will be made.

1-07.19 Gratuities

The Contractor shall not extend any loan, gratuity, or gift of money in any form whatsoever to any employee or officer of the Contracting Agency; nor will the Contractor rent or purchase any equipment or materials from any employee or officer of the Contracting Agency. Before payment of the final estimate will be made, the Contractor shall execute and furnish the Contracting Agency an affidavit certifying compliance with these provisions of the contract.

1-07.20 Patented Devices, Materials, and Processes

The Contractor shall assume all costs arising from the use of patented devices, materials, or processes used on or incorporated in the work, and agrees to indemnify, defend, and save harmless the State, Commission, Secretary, and their duly authorized agents and employees from all actions of any nature for, or on account of the use of any patented devices, materials, or processes.

1-07.21 Rock Drilling Safety Requirements

It shall be the Contractor's responsibility to maintain safe working conditions during rock drilling, by keeping dust concentration below the threshold limit value or by providing those protective devices that may be required by the State Department of Labor and Industries.

1-07.22 Use of Explosives

When using explosives, the Contractor shall use the utmost care to protect life and property, to prevent slides, and to leave undisturbed all materials, outside the neat lines of the cross-section.

Explosives shall be handled, marked, stored, and used in compliance with WAC 295-52 and such local laws, rules, and regulations that may apply. The stricter provisions, shall apply.

All explosives shall be stored securely as required by all laws and ordinances that apply. each storage place shall be clearly marked: "Dangerous-Explosives." No explosives shall be left unprotected.

If public utilities or railroads own equipment near the blast site, the Contractor shall notify the owners of the location, date, time, and approximate duration of the blasting. This notice shall be given sufficiently in advance to enable all owners to take any steps as they deem necessary to protect their property from injury.

Blasting near proposed structures shall be completed before work on them begins. When the use of explosives is necessary for the prosecution of the work, the Contractor's insurance shall contain a special clause permitting the blasting.

1-07.23 Public Convenience and Safety

1-07.23(1) Construction Under Traffic

The Contractor shall conduct all operations with the least possible obstruction and inconvenience to the public. The Contractor shall have under construction no greater length or amount of work than can be prosecuted properly with due regards to the rights of the public. To the extent possible, the Contractor shall finish each section before beginning work on the next.

To disrupt public traffic as little as possible, the Contractor shall permit traffic to pass through the work with the least possible inconvenience or delay. The Contractor shall maintain existing roads and streets within the project limits, keeping them open, and in good, clean, safe condition at all times. Deficiencies caused by the Contractor's operations shall be repaired at the Contractor's expense. Deficiencies not caused by the Contractor's operations shall be repaired by the Contractor when directed by the Engineer, at the Contracting Agency's expense. The Contractor shall also maintain roads and streets adjacent to the project limits when affected by the Contractor's operations. Snow and ice control will be performed by the Contracting Agency on all projects. Cleanup of snow and ice control debris will be at the Contracting Agency's expense. The contractor shall perform the following:

1. Remove or repair any condition resulting from the work that might impede traffic or create a hazard.
2. Keep existing traffic signal and highway lighting systems in operation as the work proceeds. (The Contracting Agency will continue the routine maintenance on such system.)

3. Maintain the striping on the roadway at the Contracting Agency's expense. The Contractor shall be responsible for scheduling when to renew striping, subject to the approval of the Engineer. When the scope of the project does not require work on the roadway, the Contracting Agency will be responsible for maintaining the striping.
4. Maintain existing permanent signing. Repair of signs will be at the Contracting Agency's expense, except those damaged due to the Contractor's operations.
5. Keep drainage structures clean to allow for free flow of water. Cleaning of existing drainage structures will be at the Contracting Agency's expense when approved by the Engineer, except when flow is impaired due to the Contractor's operations.

To protect the rights of abutting property owners, the Contractor shall:

1. Conduct the construction so that the least inconvenience as possible is caused to abutting property owners;
2. Maintain ready access to driveways, houses, and buildings along the line of work;
3. Provide temporary approaches to crossing or intersecting roads and keep these approaches in good condition; and
4. Provide another access before closing an existing one whenever the contract calls for removing and replacing an abutting owner's access.

When traffic must pass through grading areas, the Contractor shall:

1. Make cuts and fills that provide a reasonably smooth, even roadbed;
2. Place, in advance of other grading work, enough fill at all culverts and bridges to permit traffic to cross;
3. Make roadway cuts and fills, if ordered by the Engineer, in partial-width lifts, alternating lifts from side to side to permit traffic to pass on the side opposite the work;
4. Install culverts on half the width of the traveled way, keeping the other half open to traffic and unobstructed until the first half is ready for use;
5. After rough grading or placing any subsequent layers, prepare the final roadbed to a smooth, even surface (free of humps and dips) suitable for use by public traffic; and
6. Settle dust with water, or other dust palliative, as the Engineer may order.

If grading work is on or next to a roadway in use, the Contractor shall finish the grade immediately after rough grading and place surfacing materials as the work proceeds.

The Contractor shall conduct all operations to minimize any drop-offs (abrupt changes in roadway elevation) left exposed to traffic during nonworking hours. Unless otherwise specified in the Traffic Control Plan, drop-offs left exposed to traffic during nonworking hours shall be protected as follows:

1. Drop-offs up to 60 millimeters, unless otherwise ordered by the Engineer, may remain exposed with appropriate warning signs alerting motorists of the condition.
2. Drop-offs more than 60 millimeters that are in the traveled way or auxiliary lane will not be allowed unless protected with appropriate warning signs and further protected as indicated in 3b or 3c below.
3. Drop-offs more than 60 millimeters, but no more than 150 millimeters, that are not within the traveled way shall be protected with appropriate warning signs and further protected by having one of the following:
   a. A wedge of compacted stable material placed at a slope of 1:4 or flatter.

b. Channelizing devices (Type I barricades, plastic safety drums, or other devices 1 meter or more in height) placed along the traffic side of the drop-off and a new edge of pavement stripes placed a minimum of 1 meter from the drop-off. The maximum spacing between the devices in meters shall be the posted speed in kilometers per hour. Pavement drop-off warning signs shall be placed in advance and throughout the drop-off treatment.

c. Temporary concrete barrier or other approved barrier installed on the traffic side of the drop-off with 300 millimeters between the drop-off and the back of the barrier and a new edge of pavement stripe a minimum of 600 millimeters from the face of the barrier. An approved terminal, flare, or impact attenuator will be required at the beginning of the section. For night use, the barrier shall have standard delineation such as paint, reflective tape, lane markers, or warning lights.

4. Drop-offs more than 150 millimeters not within the traveled way or auxiliary lane shall be protected with appropriate warning signs and further protected as indicated in 3a, 3b, or 3c if all of the following conditions are met:
   a. The drop-off is less than 600 millimeters;
   b. The total length throughout the project is less than 1.5 kilometers;
   c. The drop-off does not remain for more than three working days;
   d. The drop-off is not present on any of the holidays listed in Section 1-08.5; and
   e. The drop-off is only on one side of the roadway.
5. Drop-offs more than 150 millimeters that are not within the traveled way or auxiliary lane and are not otherwise covered by No. 4 above shall be protected with appropriate warning signs and further protected as indicated in 3a or 3c.
6. Open trenches within the traveled way or auxiliary lane shall have a steel-plate cover placed and anchored over them. A wedge of suitable material, if required, shall be placed for a smooth transition between the pavement and the steel plate. Warning signs shall be used to alert motorists of the presence of the steel plates.

The Contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, and any other needed actions to protect the life, health, and safety of the public, and to protect property in connection with the performance of the work covered by the contract. The Contractor shall perform any measures or actions the Engineer may deem necessary to protect the public and property. The responsibility and expense to provide this protection shall be the Contractor's except that which is to be furnished by the Contracting Agency as specified in other sections of these Specifications. Nothing contained in this contract is intended to create any third-party beneficiary rights in favor of the public or any individual utilizing the highway facilities being constructed or improved under this contract.

1-07.23(2) Construction and Maintenance of Detours

Unless otherwise approved, the Contractor shall maintain two-way traffic during construction. The Contractor shall build, maintain in a safe condition, keep open to traffic, and remove when no longer needed:

1. Detours and detour bridges that will accommodate traffic diverted from the roadway or bridge during construction,
2. Detour crossings of intersecting highways, and
3. Temporary approaches.

Unit contract prices will cover construction, maintenance, and removal of all detours shown in the plans or proposed by the Contracting Agency.

The Contractor shall pay all costs to build, maintain, and remove any other detours, whether built for the Contractor's convenience or to facilitate construction operations. Any detour proposed by the Contractor shall not be built until the Engineer approves. Surfacing and paving shall be consistent with traffic requirements.

Upon failure of the Contractor to immediately provide, maintain, or remove detours or detour bridges when ordered to do so by the Engineer, the Contracting Agency may, without further notice to the Contractor or the Surety, provide, maintain, or remove the detours or detour bridges and deduct the costs from any payments due or coming due the Contractor.

1-07.24 Rights of Way

All rights of way for the completed facility will be provided by the Contracting Agency in advance of construction. Any exceptions will be noted in the special provisions. Should the necessary right of way not be available as provided in the contract, an extension of time will be considered in accordance with Section 1-08.8.

1-07.25 Opening of Sections to Traffic

The Contracting Agency reserves the right to use and open to traffic any portion of the work before the physical completion date of the entire contract without constituting acceptance of any of the work. This action will not cause the Contracting Agency to incur any liability to the Contractor except as may otherwise be provided in the contract.

If the Contracting Agency opens any portion of the work prior to the physical completion date of the entire contract because early opening is specified in the contract or when the Contractor has failed to prosecute the work continuously and efficiently, any work remaining shall be performed by the Contractor at the unit contract prices for the items of work involved. No additional payment will be made for costs incurred by the Contractor because of: (1) inconvenience, additional length of travel to conform to established traffic patterns and planned access features; (2) compliance with statutes governing traffic regulations and limitations of loads; or (3) additional flagging costs necessary to protect the operations and the traveling public. The Contractor shall take all costs due to traffic using portions of the work into account when submitting the bid proposal, and the unit contract prices for the various items of work involved shall include these costs.

1-07.26 Personal Liability of Public Officers

Neither the Commission, the Secretary, the Engineer, nor any other officer or employee of the State shall be personally liable for any acts or failure to act in connection with the contract, it being understood that in such matters, they are acting solely as agents of the State.

1-07.27 No Waiver of State's Legal Rights

The State shall not be precluded or estopped by any measurement, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor from showing the true amount and character of the work performed and materials furnished by the Contractor, or from showing that any such measurement, estimate, or certificate is untrue or incorrectly made, or that the work or materials do not conform in fact to the contract. The State shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the Contractor and the Sureties such damages as it may sustain by reason of the Contractor's failure to comply with the terms of the contract. Neither the acceptance by the Secretary, nor any payment for the whole or any part of the work, nor any extension of time, nor any possession taken by the State shall operate as a waiver of any portion of the contract or of any power herein reserved or any right to damages herein provided, or bar recovery of any money wrongfully or erroneously paid to the Contractor. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor and the State recognize that the impact of overcharges to the State by the Contractor resulting from antitrust law violations by the Contractor's suppliers or subcontractors adversely affects the State rather than the Contractor. Therefore, the Contractor agrees to assign to the State any and all claims for such overcharges.

1-08 PROSECUTION AND PROGRESS

1-08.1 Subcontracting

Work done by the Contractor's own organization shall account for at least 30 percent of the awarded contract price. Before computing this percentage, however, the Contractor may subtract (from the awarded contract price) the costs of any subcontracted work on items the contract designates as specialty items.

The Contractor shall not subcontract work unless the Engineer approves in writing. Each request to subcontract shall be on the form the Engineer provides. If the Engineer requests, the Contractor shall provide proof that the subcontractor has the experience, ability, and equipment the work requires. The Contractor shall require each subcontractor to comply with Section 1-07.9 and to furnish all certificates and statements required by the contract.

Along with the request to sublet, the Contractor shall submit the names of any contracting firms the subcontractor proposes to use as lower tier subcontractors. Collectively, these lower tier subcontractors shall not do work that exceeds 25 percent of the total amount subcontracted to a subcontractor. When a subcontractor is responsible for construction of a specific structure or structures, the following work may be performed by lower tier subcontractors without being subject to the 25 percent limitation:

1. Furnishing and driving of piling, or
2. Furnishing and installing concrete reinforcing and post-tensioning steel.

Except for the 25 percent limit, lower tier subcontractors shall meet the same requirements as subcontractors.

The Engineer will approve the request only if satisfied with the proposed subcontractor's record, equipment, experience, and ability. Approval to subcontract shall not:

1. Relieve the Contractor of any responsibility to carry out the contract,
2. Relieve the Contractor of any obligations or liability under the contract and the Contractor's bond,
3. Create any contract between the Contracting Agency and the subcontractor, or
4. Convey to the subcontractor any rights against the Contracting Agency.

The Contracting Agency will not consider as subcontracting: (1) purchase of sand, gravel, crushed stone, crushed slag, batched concrete aggregates, ready mix concrete, off-site fabricated structural steel, other off-site fabricated items, and any other materials supplied by established and recognized commercial plants; or (2) delivery of these materials to the work site in vehicles owned or operated by such plants or by recognized independent or commercial hauling companies. However, the Washington State Department of Labor and Industries may determine that RCW 39.12 applies to the employees of such firms identified in 1 and 2 above in accordance with WAC 296-127. If this should occur, the provisions of Section 1-07.9, as modified or supplemented, shall apply.

The Contractor shall certify to the actual amounts paid to any Disadvantaged, Minority, or Women's Business Enterprise firms that were used as subcontractors, lower tier subcontractors, manufacturers, regular dealers, or service providers on the contract. This certification shall be submitted to the Project Engineer annually for the State fiscal year, July 1 through June 30, or through physical completion of the contract, whichever occurs earliest. The report is due July 20th following the fiscal year end or 20 calendar days after physical completion of the contract.

If dissatisfied with any part of the subcontracted work, the Engineer may request in writing that the subcontractor be removed. The Contractor shall comply with this request at once and shall not employ the subcontractor for any further work under the contract.

1-08.2 Assignment

The Contractor shall not assign all or any part of the work unless the Engineer approves in writing. The Engineer will not approve any proposed assignment that would relieve the original Contractor or Surety of responsibility under the contract.

Money due (or that will become due) to the Contractor may be assigned. If given written notice, the Contracting Agency will honor such an assignment to the extent the law permits. But the assignment shall be subject to all setoffs, withholdings, and deductions required by law and the contract.

1-08.3 Progress Schedule

The Contractor shall submit a preliminary progress schedule (first 60 working days) to the Engineer no later than five calendar days after the date the contract is executed. This preliminary schedule shall show work to be performed during the first 60 working days of the contract.

The Contractor shall submit five copies of the progress schedule (total working days) to the Engineer no later than 30 calendar days after the date the contract is executed. This schedule and any supplemental schedule shall show: (1) physical completion of all work within the specified contract time, (2) the proposed order of work, and (3) projected starting and completion times for major phases of the work and for the total project. The schedule shall be developed by a critical path method. The Contractor shall provide sufficient material, equipment, and labor to meet the completion times in this schedule.

The Contracting Agency allocates its resources to a contract based on the total time allowed in the contract. The Contracting Agency will accept a progress schedule indicating an early physical completion date but cannot guarantee the Contracting Agency's resources will be available to meet the accelerated schedule. No additional compensation will be allowed if the Contractor is not able to meet their accelerated schedule due to the unavailability of Contracting Agency's resources or for other reasons beyond the Contracting Agency's control.

The Contractor shall submit supplemental progress schedules when requested by the Project Engineer or as required by any provision of the contract. These supplemental schedules shall reflect any changes in the proposed order of the work, any construction delays, or other conditions that may affect the progress of the work. The Contractor shall provide the Project Engineer with the supplemental progress schedules within ten calendar days of receiving written notice of the request.

The original and all supplemental progress schedules shall not conflict with any time and order-of-work requirement in the contract.

If the Engineer deems that the original or any necessary supplemental progress schedule does not provide the information required in this section, the Contracting Agency may withhold progress payments until a schedule containing the required information has been submitted by the Contractor and approved by the Engineer.

The Engineer's approval of any schedule shall not transfer any of the Contractor's responsibilities to the Contracting Agency. The Contractor alone shall remain responsible for adjusting forces, equipment, and work schedules to ensure completion of the work within the time(s) specified in the contract.

1-08.4 Prosecution of Work

The Contractor shall begin work within 10 calendar days from the date of execution of the contract by the Contracting Agency, unless otherwise approved in writing. The Contractor shall diligently pursue the work to the physical completion date within the time specified in the contract. Voluntary shutdown or slowing of operations by the Contractor shall not relieve the Contractor of the responsibility to complete the work within the time(s) specified in the contract.

1-08.5 Time for Completion

The Contractor shall complete all physical contract work within the number of "working days" stated in the contract provisions or as extended by the Engineer in accordance with Section 1-08.8. Every day will be counted as a "working day" unless it is a nonworking day or an Engineer determined unworkable day. A nonworking day is defined as a Saturday, a Sunday, a day on which the contract specifically suspends work, or one of these holidays: January 1, the third Monday of January, the third Monday of February, Memorial Day, July 4, Labor Day, November 11, Thanksgiving Day, the day after Thanksgiving, and Christmas Day. When any of these holidays fall on a Sunday, the following Monday shall be counted a nonworking day. When the holiday falls on a Saturday, the preceding Friday shall be counted a nonworking day.

The days between December 25 and January 1 will be classified as nonworking days, provided that, the Contractor actually suspends work on the project.

An unworkable day is defined as a partial or whole day the Engineer declares to be unworkable because of weather, conditions caused by the weather, or such other conditions beyond the control of the Contractor that prevents satisfactory and timely performance of the work, and such performance, if not hindered, would have otherwise progressed toward physical completion of the work.

Contract time shall begin on the first working day following the 10th calendar day after the date the Contracting Agency executes the contract. The contract provisions may specify another starting date for contract time, in which case, time will begin on the starting date specified.

Each working day shall be charged to the contract as it occurs, until the contract work is physically complete. If substantial completion has been granted and all the authorized working days have been used, charging of working days will cease. Each week the Engineer will provide the Contractor a statement that shows the number of working days: (1) charged to the contract the week before; (2) specified for the physical completion of the contract; and (3) remaining for the physical completion of the contract. The statement will also show the nonworking days and any partial or whole day the Engineer declares as unworkable. Within 10 calendar days after the date of each statement, the Contractor shall file a written protest of any alleged discrepancies in it. To be considered by the Engineer, the protest shall be in sufficient detail to enable the Engineer to ascertain the basis and amount of time disputed. By not filing such detailed protest in that period, the Contractor shall be deemed as having accepted the statement as correct.

The Engineer will give the Contractor written notice of the physical completion date for all work the contract requires. That date shall constitute the physical completion date of the contract, but shall not imply the Secretary's acceptance of the work or the contract.

The Engineer will give the Contractor written notice of the completion date of the contract after all the Contractor's obligations under the contract have been performed by the Contractor. The following events must occur before the Completion Date can be established:

1. The physical work on the project must be complete; and
2. The Contractor must furnish all documentation required by the contract and required by law, to allow the Contracting Agency to process final acceptance of the contract. The following documents must be received by the Project Engineer prior to establishing a completion date:
   a. Certified Payrolls (Federal-aid Projects)
   b. Material Acceptance Certification Documents
   c. Affidavit of Amounts Paid DBE/MBE/WBE Participants
   d. FHWA 47 (Federal-aid Projects)
   e. Final Contract Voucher Certification

1-08.6 Suspension of Work

The Engineer may order suspension of all or any part of the work if:

1. Unsuitable weather and such other conditions beyond the control of the Contractor that prevent satisfactory and timely performance of the work; or
2. The Contractor does not comply with the contract or the Engineer's orders.

When ordered by the Engineer to suspend or resume work, the Contractor shall do so immediately.

If the work is suspended for reason (1) above, the period of work stoppage will be counted as unworkable days. But if the Engineer believes the Contractor should have completed the suspended work before the suspension, all or part of the suspension period may be counted as working days. The Engineer will set the number of unworkable days (or parts of days) by deciding how long the suspension delayed the entire project.

If the work is suspended for reason (2) above, the period of work stoppage will be counted as working days. The lost work time, however, shall not relieve the Contractor from any contract responsibility.

If the performance of all or any part of the work is suspended, delayed, or interrupted for an unreasonable period of time by an act of the Contracting Agency in the administration of the contract, or by failure to act within the time specified in the contract (or if no time is specified, within a reasonable time), the Engineer will make an adjustment for any increase in the cost or time for the performance of the contract (excluding profit) necessarily caused by the suspension, delay, or interruption. However, no adjustment will be made for any suspension, delay, or interruption if (1) the performance would have been suspended, delayed, or interrupted by any other cause, including the fault or negligence of the Contractor, or (2) an equitable adjustment is provided for or excluded under any other provision of the contract.

If the Contractor believes that the performance of the work is suspended, delayed, or interrupted for an unreasonable period of time and such suspension, delay, or interruption is the responsibility of the Contracting Agency, the Contractor shall immediately submit a written notice of protest to the Engineer as provided in Section 1-04.5. No adjustment shall be allowed for any costs incurred more than 10 calendar days before the date the Engineer receives the Contractor's written notice of protest. If the Contractor contends damages have been suffered as a result of such suspension, delay, or interruption, the protest shall not be allowed unless the protest (stating the amount of damages) is asserted in writing as soon as practicable, but no later than the date of the Contractor's signature on the Final Contract Voucher Certification. The Contractor shall keep full and complete records of the costs and additional time of such suspension, delay, or interruption and shall permit the Engineer to have access to those records and any other records as may be deemed necessary by the Engineer to assist in evaluating the protest.

The Engineer will determine if an equitable adjustment in cost or time is due as provided in this section. The equitable adjustment for increase in costs, if due, shall be subject to the limitations provided in Section 1-09.4, provided that no profit of any kind will be allowed on any increase in cost necessarily caused by the suspension, delay, or interruption.

Request for extensions of time will be evaluated in accordance with Section 1-08.8.

The Engineer's determination as to whether an adjustment should be made will be final as provided in Section 1-05.1.

No claim by the Contractor under this clause shall be allowed unless the Contractor has followed the procedures provided in this Section and in Sections 1-04.5 and 1-09.11.

1-08.7 Maintenance During Suspension

Before and during any suspension (as described in Section 1-08.6) the Contractor shall protect the work from damage or deterioration. Suspension shall not relieve the Contractor from anything the contract requires unless this section states otherwise.

At no expense to the Contracting Agency, the Contractor shall provide through the construction area a safe, smooth, and unobstructed roadway for public use during suspension (as required in Section 1-07.23 or the special provisions). This may include a temporary road or detour.

If the Engineer determines that the Contractor failed to pursue the work diligently before the suspension, or failed to comply with the contract or orders, then the Contractor shall maintain the temporary roadway in use during suspension. In this case, the Contractor shall bear the maintenance costs. If the Contractor fails to maintain the temporary roadway, the Contracting Agency will do the work and deduct all resulting costs from payments due to the Contractor.

If the Engineer determines that the Contractor has pursued the work diligently before the suspension, then the Contracting Agency will do the routine maintenance work (and bear its cost). This Contracting Agency-provided maintenance work will include only routine maintenance of:

1. The traveled way, auxiliary lanes, shoulders, and detour surface,
2. Roadway drainage along and under the traveled roadway or detour, and
3. All barricades, signs, and lights needed for directing traffic through the temporary roadway or detour in the construction area.

The Contractor shall protect and maintain (and bear the costs of doing so) all other work in areas not used by traffic.

After any suspension during which the Contracting Agency has done the routine maintenance, the Contractor shall accept the traveled roadway or detour as is when work resumes. The Contractor shall make no claim against the Contracting Agency for the condition of the roadway or detour.

After any suspension, the Contractor shall retain all responsibilities the contract assigns for repairing or restoring the roadway, its slopes, and its drainage system to the requirements of the plans.

1-08.8 Extensions of Time

The Contractor shall submit any requests for time extensions to the Engineer in writing no later than 10 working days after the delay occurs. The request shall be limited to the change in the critical path of the Contractor's schedule attributable to the change or event giving rise to the request. To be considered by the Engineer, the request shall be in sufficient detail (as determined by the Engineer) to enable the Engineer to ascertain the basis and

amount of the time requested. The Contractor shall be responsible for showing on the progress schedule that the change or event: (1) had a specific impact on the critical path, and except in cases of concurrent delay, was the sole cause of such impact, and (2) could not have been avoided by resequencing of the work or other reasonable alternatives. If a request, combined with previous extension requests, equals 20 percent or more of the original contract time, the Contractor's letter of request must bear consent of Surety. In evaluating any request, the Engineer will consider how well the Contractor used the time from contract execution up to the point of the delay and the effect the delay has on any completion times included in the special provisions.

The contract's time for physical completion will be extended for a period equal to the time the Engineer determines the work was delayed because of:

1. Unsuitable weather, provided that:
    a. The Engineer had not already allowed it as an unworkable day under Section 1-08.5, and
    b. The Contractor had timely filed a written protest asserting that time the Engineer charged as a working day should have been allowed as an unworkable day.
2. Any action, neglect, or default of the Contracting Agency, its officers, or employees, or of any other contractor employed by the Contracting Agency;
3. Fire or other casualty for which the Contractor is not responsible;
4. Strikes;
5. Any other conditions for which these Specifications permit time extensions such as:
    a. In Section 1-04.4 if a change increases the time to do any of the work including unchanged work;
    b. In Section 1-04.5 if increased time is part of a protest that is found to be a valid protest;
    c. In Section 1-04.6 if increases exceed 25 percent and these increases caused a delay in completing the contract;
    d. In Section 1-04.7 if a changed condition is determined to exist which caused a delay in completing the contract;
    e. In Section 1-05.3 if the Contracting Agency does not approve properly prepared and acceptable drawings within 30 calendar days;
    f. In Section 1-07.13 if the performance of the work is delayed as a result of damage by others;
    g. In Section 1-07.17 if the removal or the relocation of any utility by forces other than the Contractor caused a delay;
    h. In Section 1-07.24 if a delay results from all the right of way necessary for the construction not being purchased and the special provisions does not make specific provisions regarding unpurchased right of way;
    i. In Section 1-08.6 if the performance of the work is suspended, delayed, or interrupted for an unreasonable period of time that proves to be the responsibility of the Contracting Agency; or
    j. In Section 1-09.11 if a dispute or claim also involves a delay in completing the contract and the dispute or claim proves to be valid.
6. Exceptional causes not specifically identified in items 1 through 5, provided the request letter proves the Contractor had no control over the cause of the delay and could have done nothing to avoid or shorten it.

Working days added to the contract by time extensions, when time has overran, shall only apply to days on which liquidated damages or direct engineering have been charged, such as the following:

If substantial completion has been granted prior to all of the authorized working days being used, then the number of days in the time extension will eliminate an equal number of days on which direct engineering charges have accrued. If the substantial completion date is established after all of the authorized working days have been used, then the number of days in the time extension will eliminate an equal number of days on which liquidated damages or direct engineering charges have accrued.

The Engineer will not allow a time extension for any cause listed above if it resulted from the Contractor's default, collusion, action or inaction, or failure to comply with the contract.

The Contracting Agency considers the time specified in the special provisions as sufficient to do all the work. For this reason, the Contracting Agency will not grant a time extension for:

- Failure to obtain all materials and workers;
- Changes, protest, increased quantities, or changed conditions (Section 1-04) that do not delay the completion of the contract or prove to be an invalid or inappropriate time extension request;
- Delays caused by nonapproval of drawings or plans as provided in Section 1-05.3;
- Rejection of faulty or inappropriate equipment as provided in Section 1-05.9;
- Correction of thickness deficiency as provided in Section 5-05.5(1)B.

The reasons for and times of extensions shall be determined by the Engineer, and such determination will be final as provided in Section 1-05.1.

1-08.9 Liquidated Damages

Time is of the essence of the contract. Delays inconvenience the traveling public, obstruct traffic, interfere with and delay commerce, and increase risk to highway users. Delays also cost tax payers undue sums of money, adding time needed for administration, engineering, inspection, and supervision.

Because the Contracting Agency finds it impractical to calculate the actual cost of delays, it has adopted the following formula to calculate liquidated damages for failure to complete the physical work of a contract on time.

Accordingly, the Contractor agrees:

1. To pay (according to the following formula) liquidated damages for each working day beyond the number of working days established for physical completion, and
2. To authorize the Engineer to deduct these liquidated damages from any money due or coming due to the Contractor.

LIQUIDATED DAMAGES FORMULA

$$LD = \frac{0.15C}{T}$$

where: LD = liquidated damages per working day (rounded to the nearest dollar)

C = original contract amount

T = original time for physical completion

When the contract work has progressed to the extent that the Contracting Agency has full and unrestricted use and benefit of the facilities, both from the operational and safety standpoint, and only minor incidental work, replacement of temporary substitute facilities, or correction or repair remains to physically complete the total contract, the Engineer may determine the contract work is substantially complete. The Engineer will notify the Contractor in writing of the substantial completion date. For overruns in contract time occurring after the date so established, the formula for liquidated damages shown above will not apply. For overruns in contract time occurring after the substantial completion date, liquidated damages shall be assessed on the basis of direct engineering and related costs assignable to the project until the actual physical completion date of all the contract work. The Contractor shall complete the remaining work as promptly as possible. Upon request by the Project Engineer, the Contractor shall furnish a written schedule for completing the physical work on the contract.

Liquidated damages will not be assessed for any days for which an extension of time is granted. No deduction or payment of liquidated damages will, in any degree, release the Contractor from further obligations and liabilities to complete the entire contract.

1-08.10 Termination of Contract

1-08.10(1) Termination for Default

The Contracting Agency may terminate the contract upon the occurrence of any one or more or the following events:

1. If the Contractor fails to supply sufficient skilled workers or suitable materials or equipment;
2. If the Contractor refuses or fails to prosecute the work with such diligence as will ensure its physical completion within the original physical completion time and any extensions of time which may have been granted to the Contractor by change order or otherwise;
3. If the Contractor is adjudged bankrupt or insolvent, or makes a general assignment for the benefit of creditors, or if the Contractor or a third party files a petition to take advantage of any debtor's act or to reorganize under the bankruptcy or similar laws concerning the Contractor, or if a trustee or receiver is appointed for the Contractor or for any of the Contractor's property on account of the Contractor's insolvency, and the Contractor or its successor in interest does not provide adequate assurance of future performance in accordance with the contract within 15 calendar days of receipt of a request for assurance from the Contracting Agency;
4. If the Contractor disregards laws, ordinances, rules, codes, regulations, orders or similar requirements of any public entity having jurisdiction;

5. If the Contractor disregards the authority of the Contracting Agency;
6. If the Contractor performs work which deviates from the contract, and neglects or refuses to correct rejected work; or
7. If the Contractor otherwise violates in any material way any provisions or requirements of the contract.

Once the Contracting Agency determines that sufficient cause exists to terminate the contract, written notice shall be given to the Contractor and its Surety indicating that the Contractor is in breach of the contract and that the Contractor is to remedy the breach within 15 calendar days after the notice is sent. In case of an emergency such as potential damage to life or property, the response time to remedy the breach after the notice may be shortened. If the remedy does not take place to the satisfaction of the Contracting Agency, the Engineer may, by serving written notice to the Contractor and Surety either:

1. Transfer the performance of the work from the Contractor to the Surety; or
2. Terminate the contract and at the Contracting Agency's option prosecute it to completion by contract or otherwise. Any extra costs or damages to the Contracting Agency shall be deducted from any money due or coming due to the Contractor under the contract.

If the Engineer elects to pursue one remedy, it will not bar the Engineer from pursuing other remedies on the same or subsequent breaches.

Upon receipt of a notice that the work is being transferred to the Surety, the Surety shall enter upon the premises and take possession of all materials, tools, and appliances for the purpose of completing the work included under the contract and employ by contract or otherwise any person or persons satisfactory to the Engineer to finish the work and provide the materials without termination of the contract. Such employment shall not relieve the Surety of its obligations under the contract and the bond. If there is a transfer to the Surety, payments on estimates covering work subsequent to the transfer shall be made to the extent permitted under law to the Surety or its agent without any right of the Contractor to make any claim.

If the Engineer terminates the contract or provides such sufficiency of labor or materials as required to complete the work, the Contractor shall not be entitled to receive any further payments on the contract until all the work contemplated by the contract has been fully performed. The Contractor shall bear any extra expenses incurred by the Contracting Agency in completing the work, including all increased costs for completing the work, and all damages sustained, or which may be sustained, by the Contracting Agency by reason of such refusal, neglect, failure, or discontinuance of work by the Contractor. If liquidated damages are provided in the contract, the Contractor shall be liable for such liquidated damages until such reasonable time as may be required for physical completion of the work. After all the work contemplated by the contract has been completed, the Engineer will calculate the total expenses and damages for the completed work. If the total expenses and damages are less than any unpaid balance due the Contractor, the excess will be paid by the Contracting Agency to the Contractor. If the total expenses and damages exceed the unpaid balance, the Contractor and the Surety shall be jointly and severally liable to the Contracting Agency and shall pay the difference to the State of Washington, Department of Transportation on demand.

In exercising the Contracting Agency's right to prosecute the physical completion of the work, the Contracting Agency shall have the right to exercise its sole discretion as to the manner, method, and reasonableness of the costs of completing the work. In the event that the Contracting Agency takes bids for remedial work or physical completion of the project, the Contractor shall not be eligible for the award of such contracts.

In the event the contract is terminated, the termination shall not affect any rights of the Contracting Agency against the Contractor. The rights and remedies of the Contracting Agency under the Termination Clause are in addition to any other rights and remedies provided by law or under this contract. Any retention or payment of monies to the Contractor by the Contracting Agency will not release the Contractor from liability.

If a notice of termination for default has been issued and it is later determined for any reason that the Contractor was not in default, the rights and obligations of the parties shall be the same as if the notice of termination had been issued pursuant to Termination for Public Convenience in Section 1-08.10(2). This shall include termination for default because of failure to prosecute the work, and the delay was found to be excusable under the provisions of Section 1-08.8.

1-08.10(2) Termination for Public Convenience

The Engineer may terminate the contract in whole, or from time to time in part, whenever:

1. The Contractor is prevented from proceeding with the work as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense; or an Executive Order of the President or Governor of the State with respect to the preservation of energy resources;
2. The Contractor is prevented from proceeding with the work by reason of a preliminary, special, or permanent restraining order of a court of competent jurisdiction where the issuance of such restraining order is primarily caused by acts or omissions of persons or agencies other than the Contractor; or
3. The Engineer determines that such termination is in the best interests of the Contracting Agency.

1-08.10(3) Payment for Termination for Public Convenience

Whenever the contract is terminated in accordance with Section 1-08.10(2), payment will be made for the actual work performed at unit contract prices for completed items of work. An equitable adjustment for partially completed items of work and disposal of materials will be made as provided in Section 1-09.5.

1-08.10(4) Termination for Public Convenience Claims

After receipt of Termination for Public Convenience as provided in Section 1-08.10(2), the Contractor shall submit to the Contracting Agency a claim for costs associated with the termination in accordance with the procedures outlined in Sections 1-09.11 and 1-09.12. The claim shall be submitted promptly but in no event later than 90 calendar days from the effective data of termination. The Contractor's claim for costs shall be priced in accordance with Sections 1-09.4 and 1-09.5. If the Contracting Agency and the Contractor cannot settle the claim, the matter will be resolved as outlined in Section 1-09.13.

If the termination occurs because of the issuance of a restraining order as provided in Section 1-08.10(2), the procedure and pricing described above remain the same except that if the parties cannot reach agreement, the matter will be resolved through mandatory and binding arbitration as described in Sections 1-09.13(3) A and B, regardless of the amount of the claim.

The Contractor agrees to make all records available to the extent deemed necessary by the Engineer to verify the claim.

1-08.10(5) Responsibility of the Contractor and Surety

Termination of a contract shall not relieve the Contractor of any responsibilities under the contract for work performed. Nor shall termination of the contract relieve the Surety or Sureties of obligations under the contract bond or retainage bond for work performed.

1-09 MEASUREMENT AND PAYMENT

1-09.1 Measurement of Quantities

In measuring all acceptably completed bid items of work, the Engineer will:

1. Use System International (SI) standard measure,
2. Make all measurements as described in this section, unless individual specifications require otherwise,
3. Follow methods generally recognized as conforming to good engineering practice,
4. Conform to the usual practice of the Contracting Agency by carrying measurements and computations to the proper significant figure or fraction of units for each item, and
5. Measure horizontally or vertically (unless otherwise specified).

The terms listed below shall be defined as follows in all measurements under this section:

"Lump Sum" (when used as an item of payment): complete payment for the work described for that item in the contract.

"Gage" (in measurement of plates): the U.S. Standard Gage.

"Gage" (in measurement of galvanized sheets used to manufacture corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing): that specified in AASHTO M 36M, M 167M, M 196M, M 197M, or M 219M.

"Gage" (in measurement of wire): that specified in AASHTO M 32.

"Tonne": 1000 kilograms.

For each basis of measurement listed below, the Engineer will use the method of measurement described. For bid items or materials measured on the basis of:

Square Meter — measured on the neat dimensions shown in the plans or as altered by the Engineer. If an individual fixture has an area of 1 square meter or less, no deductions in area will be made.

Meter (pipe culverts, guard rail, underdrains, etc.) — measured parallel to the structure's base or foundation, unless the plans require otherwise.

Mass — weighed as required in Section 1-09.2.

Volume (of excavation and embankment) — measured by the average-end-area method or by the finite element analysis method utilizing digital terrain modeling techniques. All or some computations may be based on ground elevations and other data derived photogrammetrically. The Engineer may correct for curvature.

Volume (in the hauling vehicle) — measured at the point of delivery. Hauling vehicles may be of any size or type the Engineer approves provided that the body is of such shape that the actual contents may be readily and accurately determined. If the Engineer requires, the Contractor shall level loads at the delivery point to facilitate measurement.

For each item listed below, the Engineer will use the method of measurement described.

Structures — measured on the neat lines shown in the plans or as altered by the Engineer. When a complete structure or structural unit is specified as the unit of measurement, the unit shall include all fittings and accessories.

Timber — measured by the cubic meter actually used in the structure. Measurements will be based on nominal widths and thicknesses and the extreme length of each piece.

Standard Manufactured Items (fence, wire, plates, rolled shapes, pipe conduit, etc., when specified) — measured by the manufacturer's identification of gage, unit mass, section dimension, etc. The Engineer will accept manufacturing tolerances set by each industry unless cited specifications require more stringent tolerances.

Cement — measured by the kilogram or tonne.

Asphalt — measured by the liter or tonne. If measured by liter, measurement will be made at 16°C (or will be corrected to the volume at 16°C in keeping with ASTM D 1250). If shipped by rail, truck, or transport, measurement will be by net certified scale masses or certified volumes (corrected for material lost enroute or not actually incorporated into the work). The Engineer will use the following volume-mass conversion table to compute asphalt measurements:

Conversion Factors
Average Mass and Volume of Asphalt

Grade	Liters per Tonne @ 16°C	Kilograms per Liter @ 16°C
Liquid Asphalts		
70	1056	0.947
250	1039	0.959
800	1022	0.983
3000	1005	0.995
Paving Asphalts		
AR 2000W	981	1.019
AR 4000W	981	1.019
Emulsified Asphalts		
All Grades	1005	0.995

No measurement will be made for:

1. Work performed or materials placed outside lines shown in the plans or set by the Engineer;
2. Materials wasted, used, or disposed of in a manner contrary to the contract;
3. Rejected materials (including those rejected after placement if the rejection resulted from the Contractor's failure to comply with the contract);
4. Hauling and disposing of rejected materials;
5. Material remaining on hand after the work is completed, except as provided in Sections 1-09.5 and 1-09.10; or
6. Any other work or material contrary to any contract provision.

1-09.2 Weighing Equipment

1-09.2(1) General Requirements for Weighing Equipment

Any highway or bridge construction materials to be proportioned or measured and paid for by mass, shall be weighed on scales. These materials include natural, manufactured, or processed materials obtained from natural deposits, stockpiles, or bunkers. The Contractor shall provide, set up, and maintain the scales or use permanently installed, certified, commercial scales.

Each truck to be weighed shall bear a unique identification number. This number shall be legible and in plain view of the scale operator.

Scales shall:

1. Be accurate to within one-half of 1 percent throughout the range of use;
2. Not include spring balances;
3. Include beams, dials, or other reliable readout equipment;
4. Be arranged so that operators and inspectors can safely and easily see the dials, beams, rods, and operating scale mechanisms;
5. Be built to prevent scale parts from binding, vibrating, or being displaced and to protect all working parts from falling material, wind, and weather; and
6. Be carefully maintained, with (a) bunkers and platforms kept clear of accumulated materials that could cause errors and (b) knife edges given extra care and protection.

At each batching and platform scale location, the Contractor shall have available not less than 225 kilograms of standard test mass for scale calibration and testing. If the Engineer has approved other calibration and testing equipment, the Contractor may substitute it for these masses.

1-09.2(2) Specific Requirements for Batching Scales

All materials proportioned by mass shall be weighed on an accurate, approved scale by qualified operators employed by the Contractor. Scale locations require the Engineer's approval.

Each scale shall be designed to support a weighing hopper. The arrangement shall make it convenient for the operator to remove material from the hopper while watching readout devices. Any hopper mounted on a platform scale shall have its center of gravity directly over the platform center line.

Marked intervals on the readout device shall be spaced evenly throughout and shall be based on the scale's nominal rated capacity. These intervals shall be at least 1 kilogram, but shall not exceed one-tenth of 1 percent of nominal rated capacity.

An agent of the scale manufacturer shall test and service any batch scale before its use at each new site and then at 6-month intervals. The Contractor shall provide the Engineer a copy of the final results after each test. Whenever the Engineer requests, the Contractor's operator(s) shall test the scale while the inspector observes.

Portland or asphalt cement shall be weighed on a scale not used for other materials.

1-09.2(3) Specific Requirements for Platform Scales

Each platform scale shall be able to weigh the entire hauling vehicle or combination of connected vehicles at one time. No part of the vehicle or vehicle combination will be permitted off the platform as it is weighed.

The Engineer will provide, at no cost to the Contractor, an operator to weigh and record the mass of all materials. The Contractor shall provide the platform scales and any tickets required for self-printing scales.

Unless the Engineer permits otherwise, each vehicle operator shall obtain a weigh or load ticket from the scale operator. The vehicle operator shall deliver the ticket in legible condition to the material receiver at the material delivery point.

Each weigh or load ticket shall contain gross, net, and tare mass. It shall also identify the weighed material. A tare mass shall be taken of each hauling vehicle at least twice a day.

If commercial scales are used, the Contractor shall:

1. Provide the scale operator with approved load tickets;

2. Provide duplicate, legible copies to the material receiver at the delivery point; and
3. Guarantee permission for an agent of the Engineer to observe the weighing and to check and compile the daily scale weight record.

Each commercial weigher shall test the scales at least daily. Test methods and procedures for recording test results and tare mass shall be approved in advance by the Engineer. Several times each day, the operator shall make certain the scale balances and returns to zero when the load is removed.

Any Contractor-supplied scale shall include a scale house with a floor space of at least 2 meters by 3 meters. The scale house shall be wind and weather tight, shall have windows for light and ventilation, shall include a door, and shall be lockable. It shall include a table, a chair, electrical power, and a space heater. The Contractor shall provide a rest room near the scale house.

Any platform scale shall be installed and maintained with the platform level and with rigid bulkheads at either end to prevent binding or shifting. The readout device shall be marked at intervals of no more than 20 kilograms. Test records shall show results to the nearest 10 kilograms. During weighing operations, masses shall be read and recorded to the nearest 50 kilograms.

Before use at a new site and then at 6-month intervals, the scale shall be: (a) approved under rules of the Washington State Department of Agriculture's Weights and Measures Section, or (b) serviced and tested with at least 4500 kilograms by an agent of its manufacturer. In any case, the Contractor shall provide the Engineer with a copy of the final test results.

1-09.2(4) Specific Requirements for Belt Conveyor Scales

The Engineer may approve conveyor-belt weighing of untreated materials if the method and device meet all general requirements for weighing equipment.

All belt-conveyor scales shall comply with the requirements for Belt-Conveyor Scales in the National Bureau of Standards Handbook No. 44, except where these Specifications modify those requirements.

A static load test shall be made: (a) each day after the belt-conveyor has run continuously for about 30 minutes, and (b) immediately after air temperature changes significantly. If the static load test reveals a need for adjustment, the Contractor shall make a chain test.

The Contractor shall keep available for the Engineer's review: the computation of the test chain calibration, the calibration procedures and results, and related records. The test chain shall be clearly marked with its calibration, carried in a suitable container, and immediately available for testing.

To test the accuracy of a belt-conveyor scale, the Contractor may weigh five or more payloads from sequential hauling units and compare these masses with masses of the same payloads taken on platform scales meeting the requirements of these Specifications. The Engineer will accept an average comparative accuracy of 0.5 percent. Some inaccuracies may occur with this method. This can happen because recording odometers on belt-conveyor scales are normally graduated in 90 kilogram increments and because the recording is cumulative. Thus, variations smaller than 90 kilogram may carry over from payload to payload. To reduce this chance of error, conveyor masses will be based on tonneage values taken from the sealed odometer at the beginning and end of each check period. If the test results fluctuate, the Engineer may require more than five check loads.

The Contractor shall provide self-printing, serially numbered tickets that show time and date of loading, approximate load-out weight, and the hauling vehicle's equipment number. These tickets must be approved by the Engineer. The truck driver shall imprint each ticket at a recording device at the loading point and shall deliver the ticket in legible condition to the material receiver at the material delivery point.

The recording tape, odometer, totalizer, calibration adjustment, and clock-time imprinter shall be kept locked. The Engineer shall retain all keys.

1-09.2(5) Measurement

If testing shows the scale has been underweighing, it shall be adjusted immediately. The Contractor shall not be compensated for any loss from underweighing.

If the scale has been overweighing, its operation will cease immediately until adjusted. The Contracting Agency will calculate the combined mass of all materials weighed after the last test showing accurate results. This combined mass will then be reduced by the percentage of scale error that exceeds one-half of 1 percent.

If the specifications and plans require mass measurement for minor construction items, the Contractor may request permission to convert volume to mass. If the Engineer approves, the factor of 1.48 tonnes per cubic meter of volume measure may be used to make this conversion.

1-09.2(6) Payment

The Contracting Agency will pay for no materials received by mass unless they have been weighed as required in this section or as required by another method the Engineer has approved in writing.

Payment will not be made for any material over the maximum gross legal mass for the hauling vehicle as provided in Section 1-07.7.

Unit contract prices for the various pay items of the project cover all costs related to weighing and proportioning materials for payment. These costs include those for furnishing, installing, certifying, and maintaining scales, those for furnishing check masses and scale house, and those for any other related item specified in this section.

1-09.3 Scope of Payment

The payment provided for in the contract shall be full payment to the Contractor for:

1. Furnishing all materials and performing all work under the contract (including changes in the work, materials, or plans) in a complete and acceptable manner;
2. All risk, loss, damage, or expense of whatever character arising out of the nature or prosecution of the work; and
3. All expense incurred resulting from a suspension or discontinuance of the work as specified under the contract.

The payment of any estimate or retained percentage shall not relieve the Contractor of the obligation to make good any defective work or materials.

Unless the plans and special provisions provide otherwise, the unit contract prices for the various bids items shall be full payment for all labor, materials, supplies, equipment, tools, and all other things required to completely incorporate the item into the work as though the item were to read "In Place."

If the "Payment" clause in the specifications, for an item included in the proposal, covers and considers all work and material essential to that item, then the work or materials will not be measured or paid for under any other item which may appear elsewhere in the proposal or specifications.

Certain payment items appearing in these Specifications may be modified in the plans and proposal to include:

1. The words "For Structure," "For Concrete Barrier," "For Bridge," etc. with the intent of clarifying specific use of the item; or
2. The words "Site (Site Designation)," with the intent of clarifying where a specific item of work is to be performed.

Modification of payment items in this manner shall in no way change the intent of the specifications relating to these items.

1-09.4 Equitable Adjustment

The equitable adjustment provided for elsewhere in the contract shall be determined in one or more of the following ways:

1. If the parties are able to agree, the price will be determined by using:
   a. Unit prices, or
   b. Other agreed upon prices;
2. If the parties can not agree, the price will be determined by the Engineer using:
   a. Unit prices, or
   b. Other means to establish costs.

The following limitations shall apply in determining the amount of the equitable adjustment:

1. The equipment rates shall be actual cost but shall not exceed the rates set forth in the AGC/WSDOT Equipment Rental Agreement in effect at the time the work is performed as referred to in Section 1-09.6, and
2. To the extent any delay or failure of performance was concurrently caused by the Contracting Agency and the Contractor, the Contractor shall be entitled to a time extension for the portion of the delay or failure of performance concurrently caused, provided it make such a request pursuant to Section 1-08.8; however, the Contractor shall not be entitled to any adjustment in contract price.
3. No claim for anticipated profits on deleted, terminated, or uncompleted work will be allowed.
4. No claim for consequential damages of any kind will be allowed.

1-09.5 Deleted or Terminated Work

The Engineer may delete work by change order as provided in Section 1-04.4 or may terminate the contract in whole or part as provided in Section 1-08.10(2). When the contract is terminated in part, the partial termination shall be treated as a deletion change order for payment purposes under this section.

Payment for completed items will be at unit contract prices.

When any item is deleted in whole or in part by change order or when the contract is terminated in whole or in part, payment for deleted or terminated work will be made as follows:

1. Payment will be made for the actual number of units of work completed at the unit contract prices unless the Engineer determines the unit prices are inappropriate for the work actually performed. When that determination is made by the Engineer, payment for work performed will be as mutually agreed. If the parties cannot agree the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4;

2. Payment for partially completed lump sum items will be as mutually agreed. If the parties cannot agree, the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4;
3. To the extent not paid for by the contract prices for the completed units of work, the Contracting Agency will pay as part of the equitable adjustment those direct costs necessarily and actually incurred by the Contractor in anticipation of performing the work that has been deleted or terminated;
4. The total payment for any one item in the case of a deletion or partial termination shall not exceed the bid price as modified by approved change orders less the estimated cost (including overhead and profit) to complete the work and less any amount paid to the Contractor for the item;
5. The total payment where the contract is terminated in its entirety shall not exceed the total contract price as modified by approved change orders less those amounts paid to the Contractor before the effective date of the termination; and
6. No claim for damages of any kind or for loss of anticipated profits on deleted or terminated work will be allowed because of the termination or change order.

Contract time shall be adjusted as the parties agree. If the parties cannot agree, the Engineer will determine the equitable adjustment for contract time.

Acceptable materials ordered by the Contractor prior to the date the work was terminated as provided in Section 1-08.10(2) or deleted as provided in Section 1-04.4 by the Engineer, will either be purchased from the Contractor by the Contracting Agency at the actual cost and shall become the property of the Contracting Agency, or the Contracting Agency will reimburse the Contractor for the actual costs connected with returning these materials to the suppliers.

1-09.6 Force Account

If the contract calls for work or materials to be paid for by force account, payment amounts will be determined as shown below.

1. For Labor. The Contracting Agency will reimburse the Contractor for labor and for supervision by foremen dedicated solely to the particular force account item of work (but not for supervision by general superintendents or general foremen). The Engineer will compute the labor payment on the basis of these four factors:
   a. Weighted Wage Rate. The Weighted Wage Rate combines:
      (1) the current basic wage and fringe benefits the Contractor is required and has agreed to pay,
      (2) Federal Insurance Compensation (FICA),
      (3) Federal Unemployment Tax Act (FUTA), and
      (4) State Unemployment Tax Act (SUTA)

      A Weighted Wage Rate shall be computed for each classification of labor used. This rate shall reflect the Contractor's actual cost. It shall neither exceed what is normally paid to comparable labor nor fall below the minimum required by Section 1-07.9. If the Engineer authorizes overtime, the Weighted Wage Rate shall be determined on the same basis.
   b. Travel Allowance and Subsistence. This includes the actual costs of allowances for travel or subsistence paid to employees in the course of their work on the item. This reimbursement will be made only if such allowances are required by a regional labor agreement or are normally paid by the Contractor to comparable labor for performing other work.

c. Industrial Insurance and Medical Aid Premiums. The Contracting Agency will reimburse Contractor-paid premiums for Marine Industrial Insurance, for State of Washington Industrial Insurance, and Medical Aid Premiums which become an obligation of the Contractor and are chargeable to the force account work. The Contracting Agency will not pay the Contractor for Medical Aid premiums that are paid by the employees.

d. Overhead and Profit. The Contracting Agency will pay the Contractor 20 percent of the sum of the costs listed in a, b, and c above to cover project overhead, general company overhead, profit, and any other costs incurred.

2. For Materials. The Contracting Agency will reimburse actual invoice cost for Contractor-supplied materials. This cost includes actual freight and express charges and taxes as described in Section 1-07.2 provided that these costs have not been paid in some other manner under the contract. A deduction will be made for any offered or available discounts or rebates if the Contracting Agency has provided the Contractor with the means to comply with the provisions allowing the discount. The Contracting Agency will then add 15 percent of the balance to cover project overhead, general company overhead, profit, and any other cost of supplying materials.

   To support charges for materials, the Contractor shall provide the Engineer with valid copies of vendor invoices, including freight and express bills. If invoices are not available for materials from the Contractor stocks, the Contractor shall certify actual costs by affidavit.

   If claims for materials costs are too high, inappropriate, or unsupported by satisfactory evidence, the Engineer may determine the cost for all or part of the materials. When determined in this manner, the cost will be the lowest current wholesale price from a source that can supply the required quantity (including delivery costs).

   The Contracting Agency reserves the right to provide materials. In this case, the Contractor will receive no payment for any costs, overhead, or profit.

3. For Equipment. The approval of the Engineer shall be required for the selection of machine-power tools or equipment prior to their use on force account.

   The payment for any machine-power tools or equipment shall be made according to the current AGC/WSDOT Equipment Rental Agreement which is in effect at the time the force account is authorized. The rates as set forth in the Rental Rate Blue Book (as modified by the current AGC/WSDOT Equipment Rental Agreement) are the maximum rates allowable for equipment of modern design and in good working condition. These rates shall be full compensation for all fuel, oil, lubrication, repairs, maintenance, and all other costs incidental to furnishing and operating the equipment except labor for operation.

   The Contracting Agency will add 15 percent to equipment costs to cover project overhead, general company overhead (excluding equipment overhead included in the Rental Rate Blue Book), and profit.

   Current copies of the Rental Rate Blue Book and the AGC/WSDOT Equipment Rental Agreement will be maintained at each Region office of the Department of Transportation and at each of the offices of the Associated General Contractors of America (in Seattle, Spokane, Tacoma, and Wilsonville, Oregon) where they are available for inspection.

4. Force Account Mobilization. Force account mobilization is defined as the preparatory work performed by the Contractor including transportation of tools, equipment, and personal travel time (when included in a bargaining agreement). The Contracting Agency may pay for mobilization of equipment and labor if the force account item is not an item included in the original contract proposal or such other contract items as may be included in the special provisions as being eligible for reimbursement for mobilization. Off-site work in preparation for the travel to the project, costing $300 or less will not be paid. The Contracting Agency will not pay for mobilization for off-site preparatory work for force account items under any circumstances unless the Contractor specifically makes a request in writing in advance of any such mobilization work. The written request shall include an estimate for mobilization costs involving off-site preparatory work and the basis for reimbursement. The approval of the Engineer will be required prior to commencing the mobilization for all force account. To the agreed final amount of mobilization for force account shall be added an amount equal to 15 percent of that sum for all other costs, including project overhead, general company overhead, and profit.
5. Subcontractors. The subcontractors will be allowed a 5 percent markup of the total cost computed from 1, 2, 3, and 4 for insurance, B&O tax, and bonding.
6. Contractor Markup on Subcontractors. When work is performed on a force account basis by approved subcontractors, the Contractor will be allowed an additional markup equal to 5 percent of the total cost computed for 1, 2, 3, 4, and 5 for all administrative costs.
7. Insurance, B&O Tax, and Bonding. The Contractor will be allowed an additional markup equal to 5 percent of the total cost computed for 1, 2, 3, 4, 5, and 6 for insurance, B&O tax, and bonding.

The payments provided above shall be full payment for all work done on a force account basis. The payment shall cover all expenses of every nature, kind, and description, including all overhead expenses, profit, occupational tax and any other Federal or State revenue acts, premiums on public liability and property damage insurance policies, and for the use of small tools and equipment for which no rental is allowed.

No claim for force account shall be allowed except upon written order by the Engineer prior to the performance of the work. No work shall be construed as force account work which can be measured under the specifications and paid for at the unit prices named in the contract.

The amount and costs of any work to be paid by force account shall be computed by the Engineer, and the amount certified by the Engineer shall be final as provided in Section 1-05.1.

The Contractor's wage, payroll, and cost records pertaining to work paid for on a force account basis shall be open to inspection or audit as provided in Section 1-09.12.

1-09.7 Mobilization

Mobilization consists of preconstruction expenses and the costs of preparatory work and operations performed by the Contractor which occur before 10 percent of the total original contract amount is earned from other contract items. Items which are not to be included in the item of Mobilization include but are not limited to:

1. Any portion of the work covered by the specific contract item or incidental work which is to be included in a contract item or items.

2. Profit, interest on borrowed money, overhead, or management costs.

Based on the lump sum contract price for "Mobilization," partial payments will be made as follows:

1. When 5 percent of the total original contract amount is earned from other contract items, excluding amounts paid for materials on hand, 50 percent of the amount bid for mobilization, or 5 percent of the total original contract amount, whichever is the least, will be paid.
2. When 10 percent of the total original contract amount is earned from other contract items, excluding amounts paid for materials on hand, 100 percent of the amount bid for mobilization, or 10 percent of the total original contract amount, whichever is the least, will be paid.
3. When the physical completion date has been established for the project, payment of any amount bid for mobilization in excess of 10 percent of the total original contract amount will be paid.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided by the contract.

1-09.8 Payment for Material on Hand

The Contracting Agency may reimburse the Contractor for materials purchased before their use in the work if they:

1. Meet the requirements of the plans and specifications;
2. Are delivered to or stockpiled near the project or other Engineer-approved storage sites; and
3. Consist of: sand, gravel, surfacing materials, aggregates, reinforcing steel, bronze plates, structural steel, machinery, piling, timber and lumber (not including forms or falsework), large signs unique to the project, prestressed concrete beams or girders, or other materials the Engineer may approve.

The Contracting Agency may reimburse the Contractor for traffic signal controllers as follows:

1. Fifty percent when the traffic signal controller and all components are received and assembled into a complete unit at the Olympia Service Center Materials Laboratory.
2. One hundred percent when the traffic signal controller is approved for shipment to the project by the Olympia Service Center Materials Laboratory.

The Contractor shall provide sufficient written evidence of production costs to enable the Engineer to compute the cost of Contractor-produced materials (such as sand, gravel, surfacing material, or aggregates). For other materials, the Contractor shall provide invoices from material suppliers. Each invoice shall be detailed sufficiently to enable the Engineer to determine the actual costs. Payment for materials on hand shall not exceed the total contract cost for the contract item.

If payment is based upon an unpaid invoice, the Contractor shall provide the Engineer with a paid invoice within 60 calendar days after the Contracting Agency's initial payment for materials on hand. If the paid invoice is not furnished in this time, any payment the Contracting Agency had made will be deducted from the next progress estimate and withheld until the paid invoice is supplied.

The Contracting Agency will not pay for material on hand when the invoice cost is less than $2,000. As materials are used in the work, credits equaling the partial payments for them will be taken on future estimates. Partial payment for materials on hand shall not constitute acceptance. Any material will be rejected if found to be faulty even if partial payment for it has been made.

1-09.9 Payments

The basis of payment will be the actual quantities of work performed according to the contract and as specified for payment.

Payments will be made for work and labor performed and materials furnished under the contract according to the price in the proposal unless otherwise provided.

Partial payments will be made once each month, based upon partial estimates prepared by the Engineer. Unless otherwise provided, payments will be made from the Motor Vehicle Fund.

Failure to perform any of the obligations under the contract by the Contractor may be decreed by the Contracting Agency to be adequate reason for withholding any payments until compliance is achieved.

Upon completion of all work and after final inspection (Section 1-05.11), the amount due the Contractor under the contract will be paid based upon the final estimate made by the Engineer and presentation of a Final Contract Voucher Certification signed by the Contractor. Such voucher shall be deemed a release of all claims of the Contractor unless a claim is filed in accordance with the requirements of Section 1-09.11 and is expressly excepted from the Contractor's certification on the Final Contract Voucher Certification. The date the Secretary signs the Final Contract Voucher Certification constitutes the final acceptance date (Section 1-05.12).

If the Contractor fails, refuses, or is unable to sign and return the Final Contract Voucher Certification or any other documentation required for completion and final acceptance of the contract, the Contracting Agency reserves the right to establish a completion date (for the purpose of meeting the requirements of RCW 60.28) and unilaterally accept the contract. Unilateral final acceptance will occur only after the Contractor has been provided the opportunity, by written request from the Engineer, to voluntarily submit such documents. If voluntary compliance is not achieved, formal notification of the impending establishment of a completion date and unilateral final acceptance will be provided by certified letter from the Secretary to the Contractor, which will provide 30 calendar days for the Contractor to submit the necessary documents. The 30 calendar day period will begin on the date the certified letter is received by the Contractor. The date the Secretary unilaterally signs the Final Contract Voucher Certification shall constitute the completion date and the final acceptance date (Section 1-05.12). The reservation by the Contracting Agency to unilaterally accept the contract will apply to contracts that are physically completed in accordance with Section 1-08.5, or for contracts that are terminated in accordance with Section 1-08.10. Unilateral final acceptance of the contract by the Contracting Agency does not in any way relieve the Contractor of their responsibility to comply with all Federal, State, or local laws, ordinances, and regulations that affect the work under the contract.

Payment to the Contractor of partial estimates, final estimates, and retained percentages shall be subject to controlling laws.

1-09.9(1) Retainage

Pursuant to RCW 60.28, a sum of 5 percent of the monies earned by the Contractor will be retained from progress estimates. Such retainage shall be used as a trust fund for the protection and payment (1) to the State with respect to taxes imposed pursuant to Title 82, RCW, and (2) the claims of any person arising under the Contract.

Moines retained under the provisions of RCW 60.28 shall, at the option of the Contractor, be:

1. Retained in a fund by the Contracting Agency, or
2. Deposited by the Contracting Agency in an escrow (interest-bearing) account in a bank, mutual saving bank, or savings and loan association (interest on monies so retained shall be paid to the Contractor). Deposits are to be in the name of the Contracting Agency and are not to be allowed to be withdrawn without the Contracting Agency's written authorization. The Contracting Agency will issue a check representing the sum of the monies reserved, payable to the bank or trust company. Such check shall be converted into bonds and securities chosen by the Contractor as the interest accrues.

At the time the Contract is executed the Contractor shall designate the option desired. The Contractor in choosing option (2) agrees to assume full responsibility to pay all costs which may accrue from escrow services, brokerage charges or both, and further agrees to assume all risks in connection with the investment of the retained percentages in securities. The Contracting Agency may also, at its option, accept a bond in lieu of retainage.

Release of the retainage will be made 60 days following the Completion Date (pursuant to RCW 39.12, and RCW 60.28) provided the following conditions are met:

1. On contracts totaling more than $20.000, a release has been obtained from the Washington State Department of Revenue.
2. Affidavits of Wages Paid for the Contractor and all Subcontractors are on file with the Contracting Agency (RCW 39.12.040).
3. A release has been obtained form the Washington State Department of Labor & Industries (per Section 1-07.10) and the Washington State Employment Security Department.
4. All claims, as provided by law, filed against the retainage have been resolved. In the event claims are filed and provided the conditions or 1,2, and 3 are met, the Contractor will be paid such retained percentage less an amount sufficient to pay any such claims together with a sum determined by the Contracting Agency sufficient to pay the cost of foreclosing on claims and to cover attorney's fees.

1-09.10 Payment for Surplus Processed Materials

After the Contract is completed, the Contractor will be reimbursed actual production costs for surplus processed material produced by the Contractor from Contracting Agency-provided sources if its value is $3,000 or more (determined by actual production costs).

The quantity of surplus material eligible for reimbursement of production costs shall be the quantity produced (but an amount not greater than 110 percent of plan quantity or as specified by the Engineer), less the actual quantity used. The Contracting Agency will determine the actual amount of surplus material for reimbursement.

The Contractor shall not dispose of any surplus material without permission of the Engineer. Surplus material shall remain the property of the Contracting Agency without reimbursement to the Contractor if it is not eligible for reimbursement.

1-09.11 Disputes and Claims

1-09.11(1) Disputes

When disputes occur during a contract, the Contractor shall pursue resolution through the Project Engineer. The Contractor shall follow the procedures outlined in Section 1-04.5. If the negotiation using the procedures outlined in Section 1-04.5 fails to provide satisfactory resolution, the Contractor shall pursue the more formalized method outlined in Section 1-09.11(2) for submitting a claim.

1-09.11(2) Claims

If the Contractor claims that additional payment is due and the Contractor has pursued and exhausted all the means provided in Section 1-09.11(1) to resolve a dispute, the Contractor may file a claim as provided in this section. The Contractor agrees to waive any claim for additional payment if the written notifications provided in Section 1-04.5 are not given, or if the Engineer is not afforded reasonable access by the Contractor to complete records of actual cost and additional time incurred as required by Section 1-04.5, or if a claim is not filed as provided in this section. The fact that the Contractor has provided a proper notification, provided a properly filed claim, or provided the Engineer access to records of actual cost, shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to have merit, the Engineer will make an equitable adjustment either in the amount of costs to be paid or in the time required for the work, or both. If the Engineer finds the claim to be without merit, no adjustment will be made.

All claims filed by the Contractor shall be in writing and in sufficient detail to enable the Engineer to ascertain the basis and amount of the claim. All claims shall be submitted to the Project Engineer as provided in Section 1-05.15. As a minimum, the following information must accompany each claim submitted:

1. A detailed factual statement of the claim for additional compensation and time, if any, providing all necessary dates, locations, and items of work affected by the claim.
2. The date on which facts arose which gave rise to the claim.
3. The name of each Contracting Agency individual, official, or employee involved in or knowledgeable about the claim.
4. The specific provisions of the contract which support the claim and a statement of the reasons why such provisions support the claim.
5. If the claim relates to a decision of the Engineer which the contract leaves to the Engineer's discretion or as to which the contract provides that the Engineer's decision is final, the Contractor shall set out in detail all facts supporting its position relating to the decision of the Engineer.
6. The identification of any documents and the substance of any oral communications that support the claim.
7. Copies of any identified documents, other than Contracting Agency documents and documents previously furnished to the Contracting Agency by the Contractor, that support the claim (manuals which are standard to the industry, used by the Contractor, may be included by reference).

8. If an extension of time is sought:
   a. The specific days and dates for which it is sought,
   b. The specific reasons the Contractor believes a time extension should be granted,
   c. The specific provisions of Section 1-08.8 under which it is sought, and
   d. The Contractor's analysis of its progress schedule to demonstrate the reason for a time extension.
9. If additional compensation is sought, the exact amount sought and a breakdown of that amount into the following categories:
   a. Labor;
   b. Materials;
   c. Direct equipment. The actual cost for each piece of equipment for which a claim is made or in the absence of actual cost, the rates established by the AGC/WSDOT Equipment Rental Agreement which was in effect when the work was performed. In no case shall the amounts claimed for each piece of equipment exceed the rates established by that Equipment Rental Agreement even if the actual cost for such equipment is higher. The Contracting Agency may audit the Contractor's cost records as provided in Section 1-09.12 to determine actual equipment cost. The following information shall be provided for each piece of equipment:
      (1) Detailed description (e.g., Motor Grader Diesel Powered Caterpillar 12 "G," Tractor Crawler ROPS & Dozer Included Diesel, etc.);
      (2) The hours of use or standby; and
      (3) The specific day and dates of use or standby;
   d. Job overhead;
   e. Overhead (general and administrative);
   f. Subcontractor's claims (in the same level of detail as specified herein is required for any subcontractor's claims); and
   g. Other categories as specified by the Contractor or the Contracting Agency.
10. A notarized statement shall be submitted to the Project Engineer containing the following language:

    Under the penalty of law for perjury or falsification, the undersigned,

    _____, _____
    (name) (title)

    of _____
    (company)

    hereby certifies that the claim for extra compensation and time, if any, made herein for work on this contract is a true statement of the actual costs incurred and time sought, and is fully documented and supported under the contract between the parties.

Dated _____/s/_____

Subscribed and sworn before me this _____ day of _____

_____

Notary Public

My Commission Expires: _____

It will be the responsibility of the Contractor to keep full and complete records of the costs and additional time incurred for any alleged claim. The Contractor shall permit the Engineer to have access to those records and any other records as may be required by the Engineer to determine the facts or contentions involved in the claim. The Contractor shall retain those records for a period of not less than three years after final acceptance.

The Contractor shall pursue administrative resolution of any claim with the Engineer or the designee of the Engineer.

Failure to submit with the Final Contract Voucher Certification such information and details as described in this section for any claim shall operate as a waiver of the claims by the Contractor as provided in Section 1-09.9.

Provided that the Contractor is in full compliance with all the provisions of this section and after the formal claim document has been submitted, the Contracting Agency will respond, in writing, to the Contractor as follows:

1. Within 45 calendar days from the date the claim is received by the Contracting Agency if the claim amount is less than $100,000;
2. Within 90 calendar days from the date the claim is received by the Contracting Agency if the claim amount is equal to or greater than $100,000; or
3. If the above restraints are unreasonable due to the complexity of the claim under consideration, the Contractor will be notified within 15 calendar days from the date the claim is received by the Contracting Agency as to the amount of time which will be necessary for the Contracting Agency to prepare its response.

Full compliance by the Contractor with the provisions of this section is a contractual condition precedent to the Contractor's right to seek judicial relief.

1-09.11(3) Time Limitation and Jurisdiction

For the convenience of the parties to the contract it is mutually agreed by the parties that any claims or causes of action which the Contractor has against the State of Washington arising from the contract shall be brought within 180 calendar days from the date of final acceptance (Section 1-05.12) of the contract by the State of Washington; and it is further agreed that any such claims or causes of action shall be brought only in the Superior Court of Thurston County. The parties understand and agree that the Contractor's failure to bring suit within the time period provided, shall be a complete bar to any such claims or causes of action. It is further mutually agreed by the parties that when any claims or causes of action which the Contractor asserts against the State of Washington arising from the contract are filed with the State or initiated in court, the Contractor shall permit the State to have timely access to any records deemed necessary by the State to assist in evaluating the claims or action.

1-09.12 Audits

1-09.12(1) General

The Contractor's wage, payroll, and cost records on this contract shall be open to inspection or audit by representatives of the Contracting Agency during the life of the contract and for a period of not less than three years after the date of final acceptance of the contract. The Contractor shall retain these records for that period. The Contractor shall also guarantee that the wage, payroll, and cost records of all subcontractors and all lower tier subcontractors shall be retained and open to similar inspection or audit for the same period of time. The audit may be performed by employees of the Contracting Agency or by an auditor under contract with the Contracting Agency. The Contractor, subcontractors, or lower tier subcontractors shall provide adequate facilities, acceptable to the Engineer, for the audit during normal business hours. The Contractor, subcontractors, or lower tier subcontractors shall make a good faith effort to cooperate with the auditors. If an audit is to be commenced more than 60 calendar days after the final acceptance date of the contract, the Contractor will be given 20 calendar days notice of the time when the audit is to begin. If any litigation, claim, or audit arising out of, in connection with, or related to this contract is initiated, the wage, payroll, and cost records shall be retained until such litigation, claim, or audit involving the records is completed.

1-09.12(2) Claims

All claims filed against the Contracting Agency shall be subject to audit at any time following the filing of the claim. Failure of the Contractor, subcontractors, or lower tier subcontractors to maintain and retain sufficient records to allow the auditors to verify all or a portion of the claim or to permit the auditor access to the books and records of the Contractor, subcontractors, or lower tier subcontractors shall constitute a waiver of a claim and shall bar any recovery thereunder.

1-09.12(3) Required Documents for Audits

As a minimum, the auditors shall have available to them the following documents:

1. Daily time sheets and supervisor's daily reports.
2. Collective Bargaining Agreements.
3. Insurance, welfare, and benefits records.
4. Payroll registers.
5. Earnings records.
6. Payroll tax forms.
7. Material invoices and requisitions.
8. Material cost distribution worksheet.
9. Equipment records (list of company equipment, rates, etc.).
10. Vendors', rental agencies', subcontractors', and lower tier subcontractors' invoices.
11. Contracts between the Contractor and each of its subcontractors, and all lower-tier subcontractor contracts and supplier contracts.
12. Subcontractors' and lower tier subcontractors' payment certificates.
13. Canceled checks (payroll and vendors).
14. Job cost reports, including monthly totals.
15. Job payroll ledger.
16. General ledger.
17. Cash disbursements journal.

18. Financial statements for all years reflecting the operations on this contract. In addition, the contracting Agency may require, if it deems appropriate, additional financial statements for 3 years preceding execution of the contract and 3 years following final acceptance of the contract.
19. Depreciation records on all company equipment whether these records are maintained by the company involved, its accountant, or others.
20. If a source other than depreciation records is used to develop costs for the Contractor's internal purposes in establishing the actual cost of owning and operating equipment, all such other source documents.
21. All documents which relate to each and every claim together with all documents which support the amount of damages as to each claim.
22. Worksheets or software used to prepare the claim establishing the cost components for items of the claim including but not limited to labor, benefits and insurance, materials, equipment, subcontractors, all documents which establish the time periods, individuals involved, the hours for the individuals, and the rates for the individuals.
23. Worksheets, software, and all other documents used by the Contractor to prepare its bid.

An audit may be performed by employees of the Contracting Agency or a representative of the Contracting Agency. The Contractor and its subcontractors shall provide adequate facilities acceptable to the Contracting Agency for the audit during normal business hours. The Contractor and all subcontractors shall cooperate with the Contracting Agency's auditors.

1-09.13 Claims Resolution

1-09.13(1) General

Prior to seeking claim resolution through nonbinding alternative dispute resolution processes, binding arbitration, or litigation, the Contractor shall proceed under the administrative procedures in Sections 1-04.5, 1-09.11 and any special provision provided in the contract for resolution of disputes. The provisions of these sections must be complied with in full, as a condition precedent to the Contractor's right to seek claim resolution through any nonbinding alternative dispute resolution process, binding arbitration or litigation.

1-09.13(2) Nonbinding Alternative Disputes Resolution (ADR)

Nonbinding ADR processes are encouraged and available upon mutual agreement of the Contractor and the Contracting Agency for all claims submitted in accordance with Section 1-09.11, provided that:

1. All the administrative remedies provided for in the contract have been exhausted;
2. The Contracting Agency has been given the time and opportunity to respond to the Contractor as provided in Section 1-09.11(2); and
3. The Contracting Agency has determined that it has sufficient information concerning the Contractor's claims to participate in a nonbinding ADR process.

The Contracting Agency and the Contractor mutually agree that the cost of the nonbinding ADR process shall be shared equally by both parties with each party bearing its own preparation costs.

The type of nonbinding ADR process shall be agreed upon by the parties and shall be conducted within the State of Washington at a location mutually acceptable to the parties.

The Contractor agrees that the participation in a nonbinding ADR process does not in any way waive the requirement that binding arbitration or litigation proceedings must commence within 180 calendar days of final acceptance of the contract, the same as any other claim or causes of action as provided in Section 1-09.11(3).

1-09.13(3) Claims $250,000 or Less

The Contractor and the Contracting Agency mutually agree that those claims which total $250,000 or less, submitted in accordance with Section 1-09.11 and not resolved by nonbinding ADR processes, shall be resolved through mandatory and binding arbitration as described herein.

1-09.13(3)A Administration of Arbitration

Arbitration shall be as agreed by the parties or, if the parties cannot agree, arbitration shall be administered through the American Arbitration Association (AAA) using the following arbitration methods:

1. The current version of the Northwest Region Expedited Commercial Arbitration Rules shall be used for claims with an amount less than $25,000.
2. The current version of the Expedited Procedures of the Construction Industry Arbitration Rules shall be used for claims with an amount equal to or greater than $25,000 and less than $50,000.
3. The current version of the standard procedures of the Construction Industry Arbitration Rules shall be used for claims with an amount equal to or greater than $50,000 and not greater than $250,000.

The Contracting Agency and the Contractor mutually agree the venue of any arbitration hearing shall be within the State of Washington and any such hearing shall be conducted within the State of Washington.

The Contracting Agency and the Contractor mutually agree to be bound by the decision of the arbitrator, and judgment upon the award rendered by the arbitrator may be entered in the Superior Court of Thurston County. The decision of the arbitrator and the specific basis for the decision shall be in writing. The arbitrator shall use the contract as a basis for decisions.

1-09.13(3)B Procedures to Pursue Arbitration

If the dispute cannot be resolved through administrative procedures provided in Sections 1-04.5, 1-09.11, and any special provision provided in the contract for resolution of disputes or through a mutually agreed upon nonbinding ADR process, the Contractor shall advise the Engineer, in writing, that mandatory and binding arbitration is desired. The parties may agree on an arbitration process, or, if the parties cannot agree a demand for arbitration shall be filed by the Contractor, in accordance with the AAA rules, with the Contracting Agency, and with the AAA. Selection of the arbitrator and the administration of the arbitration shall proceed in accordance with AAA rules using arbitrators from the list developed by the AAA, except that: for claims under $25,000 using the Northwest Region Expedited Commercial Arbitration Rules, arbitration selection shall proceed pursuant to Section 55 of the Expedited Procedure of the Construction Industry Arbitration Rules. Arbitration shall proceed utilizing the appropriate rule of the AAA as determined by the dollar amount of the claim as provided in Section 1-09.13(3)A.

Unresolved disputes which do not involve delays or impacts to unchanged work may be brought to binding arbitration prior to physical completion of the project, provided that:

1. All the administrative remedies provided for in the contract have been exhausted;
2. The dispute has been pursued to the claim status as provided in Section 1-09.11(2); and
3. The Contractor certifies in writing that claims for delays or impacts to the work will not result from the dispute.

Unless the Contracting Agency and the Contractor agree otherwise, all other unresolved claims (disputes which have been pursued to the claim status) which arise from a contract must be brought in a single arbitration hearing and only after physical completion of the contract. The total of those unresolved claims cannot be greater than $250,000 to be eligible for arbitration.

In addition, the Contractor agrees arbitration proceedings must commence, by filing of the aforementioned demand for arbitration, within 180 calendar days of final acceptance of the contract, the same as any other claim or causes of action as provided in Section 1-09.11(3).

The scope and extent of discovery shall be determined by the arbitrator in accordance with AAA rules. In addition, each party for claims greater than $25,000 shall serve upon the other party a "statement of proof." The statement of proof shall be served, with a copy to the AAA, no less than 20 calendar days prior to the arbitration hearing and shall include:

1. The identity, current business address, and residential address of each witness who will testify at the hearing,
2. The identity of a witness as an expert if an expert witness is to be called, a statement as to the subject matter and the substance of the facts and opinions on which the expert is expected to testify, a summary of the grounds for each opinion, and a resume of the expert's qualifications, and
3. A list of each document that the party intends to offer in evidence at the arbitration hearing. Either party may request from the other party a copy of any document listed. If such a request is made, a copy of the document shall be provided within five calendar days from the date the request is received.

The arbitrator may permit a party to call a witness or offer a document not shown or included in the statement of proof only upon a showing of good cause.

1-09.13(4) Claims in Excess of $250,000

The Contractor and the Contracting Agency mutually agree that those claims in excess of $250,000, submitted in accordance with Section 1-09.11 and not resolved by non-binding ADR processes, shall be resolved through litigation unless the parties mutually agree to resolve the claim through binding arbitration.

1-10 TEMPORARY TRAFFIC CONTROL

1-10.1 General

The Contractor shall provide flaggers, signs, and other traffic control devices not otherwise specified as being furnished by the Contracting Agency. The Contractor shall erect and maintain all construction signs, warning signs, detour signs, and other traffic control devices necessary to warn and protect the public at all times from injury or damage as a result of the Contractor's operations which may occur on highways, roads, or streets. No work shall be done on or adjacent to the roadway until all necessary signs and traffic control devices are in place.

These flaggers, signs, and other traffic control devices shall be used for the safety of the public, the Contractor's employees, and Contracting Agency's personnel and to facilitate the movement of the traveling public. They may be used for the separation or merging of public and construction traffic when in accordance with a specific approved traffic control plan.

Upon failure of the Contractor to immediately provide flaggers; erect, maintain, and remove signs; or provide, erect, maintain, and remove other traffic control devices when ordered to do so by the Engineer, the Contracting Agency may, without further notice to the Contractor or the Surety, perform any of the above and deduct all of the costs from the Contractor's payments.

The Contractor shall be responsible for providing adequate flaggers, signs, and other traffic control devices for the protection of the work and the public at all times regardless of whether or not the flaggers, signs, and other traffic control devices are ordered by the Engineer, furnished by the Contracting Agency, or paid for by the Contracting Agency. The Contractor shall be liable for injuries and damages to persons and property suffered by reason of the Contractor's operations or any negligence in connection therewith.

1-10.2 Traffic Control Management

1-10.2(1) General

The Contractor shall designate an individual or individuals to perform the duties of Traffic Control Manager (TCM) and Traffic Control Supervisor (TCS). The TCM and TCS shall be certified as a worksite traffic control supervisor by one of the organizations listed in the Special Provisions. A TCM and TCS are required on all projects that have traffic control. The TCM can also perform the duties of the TCS. The Contractor shall identify an alternate TCM and TCS that can assume the duties of the assigned or primary TCM and TCS in the event of that person's inability to perform. Such alternates shall be adequately trained and certified to the same degree as the primary TCM and TCS.

The Contractor shall maintain 24-hour telephone numbers at which the TCM and TCS can be contacted and be available upon the Engineers request at other than normal working hours. The TCM and TCS shall have appropriate personnel, equipment, and material available at all times in order to expeditiously correct any deficiency in the traffic control system.

1-10.2(1)A Traffic Control Manager

The duties of the Traffic Control Manager include:

1. Discussing proposed traffic control measures and coordinating implementation of the Contractor-adopted traffic control plan(s) with the Engineer.

2. Coordinating all traffic control operations, including those of subcontractors, suppliers, and any adjacent construction or maintenance operations.
3. Coordinating the project's activities (such as ramp closures, road closures, and lane closures) with appropriate police, fire control agencies, city or county engineering, medical emergency agencies, school districts, and transit companies.
4. Overseeing all requirements of the contract which contribute to the convenience, safety, and orderly movement of vehicular and pedestrian traffic.
5. Having the latest adopted edition of the MUTCD including the Modifications to the MUTCD for Streets and Highways for the State of Washington and applicable standards and specifications available at all times on the project.
6. Attending all project meetings where traffic management is discussed.
7. Review TCS's diaries daily and be responsible for knowing "field" traffic control operations.

1-10.2(1)B Traffic Control Supervisor

A TCS shall be on the project whenever traffic control labor is required or as authorized by the Engineer.

The TCS shall personally perform all the duties of the TCS. During nonwork periods, the TCS shall be able to be on the jobsite within a 45 minute time period after notification by the Engineer.

The TCS's duties shall include:

1. Inspecting traffic control devices and nighttime lighting for proper location, installation, message, cleanliness, and effect on the traveling public. Traffic control devices shall be inspected each work shift except that Class A signs and nighttime lighting need to be checked only once a week. Traffic control devices left in place for 24 hours or more should also be inspected once during the nonworking hours when they are initially set up (during daylight or darkness, whichever is opposite of the working hours).
2. Preparing a daily traffic control diary on DOT Forms 421-040A and 421-040B, which shall be submitted to the Engineer no later than the end of the next working day to become a part of the project records. The Contractor may use their own form if it is approved by the Engineer. Include in the diary such items as:
   a. When signs and traffic control devices are installed and removed,
   b. Location and condition of signs and traffic control devices,
   c. Revisions to the traffic control plan,
   d. Lighting utilized at night, and
   e. Observations of traffic conditions.
3. Ensuring that corrections are made if traffic control devices are not functioning as required. The TCS may make minor revisions to the traffic control plan to accommodate site conditions as long as the original intent of the traffic control plan is maintained and - the revision has concurrence of the WSDOT TCS.
4. Attending traffic control coordinating meetings or coordination activities as authorized by the Engineer.

The TCS may perform the work described by Traffic Control Labor" as long as the duties of the TCS are accomplished. Possession of a current flagging card by the TCS is mandatory.

A reflective vest and hard hat shall be worn by the TCS.

1-10.2(2) Traffic Control Plans

The traffic control plan or plans appearing in the contract plans show a method of handling traffic. All flaggers are to be shown on the traffic control plan except for emergency situations. The Contractor shall designate and adopt in writing the specific traffic control plan or plans required for their method of performing the work. If the Contractor's methods differ from the contract traffic control plan(s), the Contractor shall propose modification of the traffic control plan(s) by showing the necessary construction signs, flaggers, and other traffic control devices required for the project. The Contractor's modified traffic control plan(s) shall be in accordance with the established standards for plan development as shown in the MUTCD, Part VI. The Contractor's letter designating and adopting the specific traffic control plan(s) or any proposed modified plan(s) shall be submitted to the Engineer for approval at least ten calendar days in advance of the time the signs and other traffic control devices will be required.

1-10.2(3) Conformance to Established Standards

Flagging, signs, and all other traffic control devices furnished or provided shall conform to the standards established in the latest adopted edition of the "*Manual on Uniform Traffic Control Devices*" (MUTCD) published by the U.S. Department of Transportation and the Modifications to the MUTCD for Streets and Highways for the State of Washington. Copies of the MUTCD may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Modifications to the MUTCD for Streets and Highways for the State of Washington may be obtained from the Department of Transportation, Olympia, Washington 98504.

Category 1 traffic control devices includes those items that are small and lightweight, channelizing, and delineating devices that have been in common use for many years and are known to be crashworthy by crash testing of similar devices or years of demonstrable safe performance. These include cones, tubular markers, flexible delineator posts, and plastic drums with no attachments. All Category 1 devices used by the project shall meet the requirements of National Cooperative Highway Research Project (NCHRP) Report 350 as certified by the manufacturer of the device. The Contractor shall obtain the manufacturer's certification documentation for all such devices purchased and shall keep the documentation available for inspection throughout the life of the project.

The condition of signs and traffic control devices shall be new or "acceptable" as defined in the book Quality Standards For Work Zone Traffic Control Devices, and will be accepted based on a visual inspection by the Engineer. The Engineer's decision on the condition of a sign or traffic control device shall be final. When a sign or traffic control device becomes classified as "not acceptable" it shall be removed from the project and replaced within 12 hours.

1-10.3 Flagging, Signs, and All Other Traffic Control Devices

1-10.3(1) Traffic Control Labor

The Contractor shall furnish all personnel for flagging and for the setup and removal of all temporary traffic control devices and construction signs necessary to control traffic during construction operations. Prior to performing any traffic control work on the project, these personnel shall be trained with the video, "Safety in the Work Zone" produced jointly by WSDOT and Laborers' International Union of North America. The video is available from WSDOT's Engineering Publications Office, Transportation Building.

Flaggers and spotters shall possess a current flagging card issued by the State of Washington, Oregon, or Idaho. The flagging card shall be immediately available and shown upon request by the Contracting Agency. Workers engaged in flagging or traffic control shall wear reflective vests and hard hats. During hours of darkness, white coveralls or white or yellow rain gear shall also be worn. The vests and other apparel shall be in conformance with Section 1-07.8. During hours of darkness flagger stations shall be illuminated to ensure that flaggers can easily be seen without causing glare to the traveling public. The Contractor shall furnish the MUTCD standard Stop/Slow paddles (460 millimeters wide, letters 150 millimeters high, and reflectorized) for the flagging operations.

When the bid proposal includes an item for "Traffic Control Labor," the work covered by this item shall be limited to the labor required in the "work areas" defined in Section 1-10.5 for:

1. Flagging;
2. Handling the Class B construction signs and other temporary traffic control devices only for:
   a. Set up and removal;
   b. Relocation to and from temporary storage, provided that, the use and location of the temporary storage is approved by the Engineer;
   c. Relocation on the project, provided that, the new locations are in accordance with the contract plans, approved traffic control plan, or the orders of the Engineer; and
   d. Cleaning up and removing construction signs and traffic control devices on the project that are damaged or destroyed by a third party,
3. Operating the vehicle(s) described in Section 1-10.3(2) while transporting the Class B construction signs and other temporary traffic control devices; and
4. Cleaning the Class B construction signs, the other temporary traffic control devices, and the Class A construction signs, when they become illegible because of weather or other conditions and the Engineer orders them to be cleaned.
5. Spotters to warn work crews of impending danger from public traffic, when approved by the Engineer.

The hours eligible for "Traffic Control Labor" will be those hours actually used for the previously described work. Any work described under this section performed by a Traffic Control Supervisor will not be paid as "Traffic Control Labor" but will be covered by the item "Traffic Control Supervisor" per hour.

1-10.3(2) Traffic Control Vehicle

When the bid proposal includes an item "Traffic Control Vehicle," the work required for this item is furnishing a vehicle or vehicles for the traffic control supervisor and for transporting the Class B construction signs and other temporary traffic control devices in the "work area" defined in Section 1-10.5. The eligible work for transporting signs shall be limited to:

1. Set up and removal;
2. Relocation to and from temporary storage, provided that, the use and location of the temporary storage is approved by the Engineer; and
3. Relocation on the project, provided that, the new locations are in accordance with the contract plans, approved traffic control plan, or the orders of the Engineer.

The traffic control vehicle shall be equipped with a roof or post-mount flashing amber light visible for 360 degrees.

1-10.3(3) Construction Signs

All signs required by the approved traffic control plan(s) as well as any other appropriate signs prescribed by the Engineer will be furnished by the Contracting Agency. The Contractor shall provide the posts or supports and erect and maintain the signs in a clean, neat, and presentable condition until the necessity for them has ceased. All nonapplicable signs shall be removed or completely covered with either metal or plywood during periods when they are not needed. When the need for any of these signs has ceased, the Contractor, upon approval of the Engineer, shall take down these signs, posts, or supports. All posts or supports shall be removed from the project and shall remain the property of the Contractor. The Contracting Agency-furnished signs shall be returned to the Engineer in good condition. All such signs lost, stolen, damaged, or destroyed shall be replaced by the Contractor in kind at the Contractor's expense or their value will be deducted from the Contractor's payments.

Construction signs will be divided into two classes. Class A construction signs are those signs that remain in service throughout the construction or during a major phase of the work. They are mounted on posts, existing fixed structures, or substantial supports of a semi-permanent nature. Sign and support installation for Class A signs shall be in accordance with the Contract Plans or the Standard Plans. Class B construction signs are those signs that are placed and removed daily, or are used for short durations which may extend for one or more days. They are mounted on portable or temporary mountings. If it is necessary to add weight to the signs for stability, only a bag of sand that will rupture on impact shall be used. The bag of sand shall: (1) be furnished by the Contractor, (2) have a maximum mass of 18 kilograms, and (3) be suspended no more than 300 millimeters from the ground. In the event of disputes, the Engineer will determine if a construction sign is considered as a Class A or B construction sign.

When Class A or B construction signs are required, the work to provide these signs shall be:

1. Furnishing, removing, and disposing of the posts or supports for the signs;
2. Initial acquisition from the Engineer and ultimate return to the Engineer of the required Contracting Agency-furnished signs;
3. Initial installation and subsequent removal of both Class A and B construction signs; and
4. All other incidentals necessary for providing Class A or B construction signs according to the approved traffic control plan(s).

No item will be provided in the bid proposal for Class B construction signs. Payment for Class B construction signs will be limited to the labor cost to do the work described in Section 1-10.3(1). All other costs for the work to provide Class B construction signs shall be included in the unit contract price for the various other items of the work in the bid proposal.

Signs, posts, or supports that are lost, stolen, damaged, destroyed, or which the Engineer deems to be unacceptable, while their use is required on the project, shall be replaced by the Contractor without additional compensation.

1-10.3(4) No Passing Zones

The striping of no passing zones that are to be obliterated in excess of 45 meters by paving operations shall be replaced by "Do Not Pass" and "Pass With Care" signs. The signs shall be located not less than 600 millimeters outside the usable shoulder nor less than 2.1 meters above the edge of pavement. The number of necessary signs will be specified

in the contract provisions. The Contractor shall provide posts and install the Contracting Agency-furnished signs. The signs shall be maintained by the Contractor until construction operations are complete. When the project includes striping by the Contractor, the signs and posts shall be removed by the Contractor when the no passing zones are reestablished by striping. The signs shall be returned to the Contracting Agency, and the posts will become the property of the Contractor. When the Contractor is not responsible for striping, the posts and signs shall become the property of the Contracting Agency and will be removed by Contracting Agency forces when the no passing zones are reestablished by striping. Payment to perform the work required for this subsection will be under the item "Construction Sign Class A."

1-10.3(5) Temporary Traffic Control Devices

When the bid proposal includes an item for "Temporary Traffic Control Devices," the work required for this item shall be furnishing barricades, flashers, cones, traffic safety drums, and other temporary traffic control devices unless the contract provides for furnishing a specific temporary traffic control device under another item. The item "Temporary Traffic Control Devices" includes:

1. Initial delivery to the project site (or temporary storage) in good repair and in clean usable condition,
2. Repair or replacement when they are damaged and they are still needed on the project, and
3. Removal from the project site when they are no longer needed on the project.

1-10.3(6) One-Way Piloted Traffic Control Through Construction Zone

The construction sometimes requires that traffic be maintained on a portion of the roadway during the progress of the work using one-way piloted traffic control. If this is the case, the Contractor's operation shall be confined to one-half the roadway, permitting traffic on the other half. If, in the opinion of the Engineer, one-way piloted traffic control is necessary, it shall be provided for in one of the following manners:

Contracting Agency-Furnished One-Way Piloted Traffic Control. The Contracting Agency will furnish, without cost to the Contractor, two flaggers to control traffic at the ends of the pilot car control area and will furnish a pilot car and driver to lead the traffic through the area. All other necessary flaggers within the limits of the pilot car control area shall be furnished by the Contractor as provided in Section 1-10.3(1). If the Contracting Agency is to provide piloted traffic control, the contract provisions will prescribe the extent of the Contracting Agency-Furnished One-Way Piloted Traffic Control.

Contractor-Furnished One-Way Piloted Traffic Control. The Contractor shall furnish the pilot car(s) and driver(s) for the pilot car control area. Any necessary flaggers shall be furnished by the Contractor as provided in Section 1-10.3(1).

When the bid proposal includes an item for "Contractor Piloted Traffic Control," measurement and payment will be as provided in Section 1-10.4 and 1-10.5.

As conditions permit, the Contractor shall, at the end of each day, leave the work area in such condition that it can be traveled without damage to the work, without danger to traffic, and without one-way piloted traffic control. The Engineer will be the sole judge as to whether or not piloting can be dispensed with after working hours. If piloting is required after working hours due to carelessness or negligence on the part of the Contractor to

properly condition the work at the end of the day, such piloting costs shall be borne by the Contractor. If the Contracting Agency is furnishing the piloting, the costs charged to the Contractor will include the pilot car, the pilot car driver, and the two flaggers.

The Contractor shall be responsible for protection of the work and traffic at all times regardless of flagging and pilot car services furnished by the Contracting Agency, and the Contractor shall be liable for damages and injuries suffered by reason of the Contractor's operations or any negligence in connection therewith.

1-10.4 Measurement

Contractor piloted traffic control will be by the hour for any one pilot car control area. Portions of an hour will be rounded up to a whole hour.

Traffic control labor will be by the hour for each hour a person is actually performing the work described in Section 1-10.3(1). Portions of an hour will be rounded up to a whole hour.

Class A construction signs will be by the square meter of panel area. A Class A construction sign may be used in more than one location and will be measured for payment for each new installation. Class B construction signs will not be measured for payment. Sign posts or supports will not be measured for payment.

Traffic control supervisor will be measured per hour for each hour a person is actually performing the duties described in Section 1-10.2(1)B as authorized by the Engineer. Portions of an hour will be rounded up to a whole hour. A minimum of 4 hours will be paid when the Engineer authorizes the TCS to be on the jobsite during nonworking shifts.

No unit of measure will apply to the position of traffic control manager and it will be considered incidental to unit contact prices. When the traffic control manager performs the duties of the traffic control supervisor, measurement and payment will be as specified for the traffic control supervisor.

No specific unit of measurement will apply to the lump sum item of temporary traffic control devices.

Traffic control vehicle will be by the day on the days when a vehicle or vehicles are actually being used to perform the work described in Section 1-10.3(2). More than one vehicle may be used to perform this work, however, all vehicles used on any day will be measured as one unit for that day. Vehicles required to be furnished by any other specifications such as Sections 1-10.2(1) and 1-10.3(6) may be used for doing the work required by Section 1-10.3(2), however, those vehicles will not be measured for payment under this section.

The days eligible for "Traffic Control Vehicle" will be those days that a vehicle or vehicles are actually used for the previously described work. The Contractor may use more than one vehicle to perform this work, however, all the vehicles used will be considered one unit for the days that more than one vehicle is used. Vehicles required to be furnished by any other specifications such as Section 1-10.3(6) may be used for doing the work required by this section but will be excluded from payment under this section.

1-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Contractor Piloted Traffic Control," per hour.

The unit contract price per hour shall be full pay for all costs involved in furnishing the pilot car(s), pilot car driver(s), and the appropriate pilot car sign(s) for any one pilot car operation. Any necessary flaggers will be paid under the item for traffic control labor.

"Traffic Control Labor," per hour.

The unit contract price per hour shall be full pay for all costs for the labor provided for performing those construction operations described in Section 1-10.3(1) and as authorized by the Engineer. Payment under this item shall be limited to the hours the worker is actually performing the work.

"Construction Signs Class A," per square meter panel area.

The unit contract price per square meter of panel area shall be full pay for all costs for performing the work described in Section 1-10.3(3) and Section 1-10.3(4). This payment will include all labor, equipment, and vehicles necessary for the initial acquisition, the initial installation of Class A signs, and ultimate return of all Contracting Agency-furnished signs. Payment will not be made for signs delivered to, or removed from, the project without the approval of the Engineer.

"Traffic Control Supervisor," per hour.

The unit contract price per hour for "Traffic Control Supervisor" shall be full pay for each hour a person performs the duties described in Sections 1-10.2(1)B including when performing traffic control labor duties.

"Temporary Traffic Control Devices, " lump sum.

The lump sum contract price shall be full pay for all costs for providing the work described in Section 1-10.3(5). Progress payment for the lump sum item "Temporary Traffic Control Devices" will be made as follows:

a. When the initial temporary traffic control devices are set up, 50 percent of the amount bid for the item will be paid.
b. Payment for the remaining 50 percent of the amount bid for the item will be paid on a prorated basis in accordance with the total job progress as determined by progress payments.

"Traffic Control Vehicle," per day.

The unit contract price per day shall be full pay for all costs involved in furnishing the vehicle or vehicles for the work described in Sections 1-10.2(1) and 1-10.3(2). The operator(s) of the vehicle(s) will be paid for under the item "Traffic Control Labor" or "Traffic Control Supervisor."

When the bid proposal does not include an item for any necessary traffic control, all costs for traffic control shall be included, by the Contractor, in the unit contract price for the various other items of work in the bid proposal. The Contractor shall estimate these costs based on the Contractor's contemplated work procedures.

When traffic control items are included in the bid proposal, payment is limited to the following work areas:

1. The entire construction area under contract and for a distance to include the initial warning signs for the beginning of the project and the end of construction sign. Any warning signs for side roads on the approved traffic control plan are also included. If the project consists of two or more sections, the limits will apply to each section individually.
2. A detour provided in the plans or approved by the Engineer for by-passing all or any portion of the construction, irrespective of whether or not the termini of the detour are within the limits of the contract.

3. The initial point of entry to or crossing of the public road system from Contracting Agency-furnished quarry, pit, borrow, or waste sites, or from Contracting Agency-furnished haul roads serving those sites, when outside the limits in 1 above.

No payment will be made to the Contractor for traffic control items required in connection with the movement of equipment or the hauling of materials outside the limits of 1, 2, and 3 above.

American Public Works Association

DIVISION 1
APWA SUPPLEMENT

The following pages identified as APWA Supplement, are for the purpose of revising, replacing, or adding to the sections of Division 1. Collectively these revisions, replacements, and additions are called Supplements. These Supplements are to be used only when the bid documents specifically state that the APWA Supplement will apply for the contract and are to be used only for city and county projects that are advertised and awarded at the local level. These Supplements do not apply to any project that is administered by the Washington State Department of Transportation.

1-99 APWA SUPPLEMENT

SECTION 1-01.3 IS SUPPLEMENTED BY ADDING THE FOLLOWING DEFINITIONS:

All references in the Standard Specifications to the terms “State”, “Department of Transportation”, “Washington State Transportation Commission”, “Commission”, “Secretary of Transportation”, “Secretary”, “Headquarters”, and “State Treasurer” shall be revised to read “Contracting Agency”.

All references to “Olympia Service Center Materials Laboratory” shall be revised to read “Contracting Agency designated location”.

The venue of all causes of action arising from the contract shall be in the Superior Court of the county where the Contracting Agency’s headquarters is located.

1-01.3 Definitions (APWA only)

Additive (APWA only)

A supplemental unit of work or group of bid items, identified separately in the proposal, which may, at the discretion of the Contracting Agency, be awarded in addition to the base bid.

Alternate (APWA only)

One of two or more units of work or groups of bid items, identified separately in the proposal, from which the Contracting Agency may make a choice between different methods or material of construction for performing the same work.

Contract Documents (APWA only)

See definition for “Contract”.

Contract Time (APWA only)

The period of time established by the terms and conditions of the contract within which the work must be physically completed.

Dates (APWA only)

Bid Opening Date

The date on which the Contracting Agency publicly opens and reads the bids.

Award Date

The date of the formal decision of the Contracting Agency to accept the lowest responsible and responsive bidder for the work.

Contract Execution Date

The date the Contracting Agency officially binds the agency to the contract.

Notice to Proceed Date

The date stated in the Notice to Proceed on which the contract time begins.

Substantial Completion Date

The day the Engineer determines the Contracting Agency has full and unrestricted use and benefit of the facilities, both from the operational and safety standpoint, and only minor incidental work, replacement of temporary substitute facilities, or correction or repair remains for the physical completion of the total contract.

Contract Completion Date

The date by which the work is contractually required to be physically completed. The Contract Completion Date will be stated in the Notice to Proceed. Revisions of this date will be authorized in writing by the Engineer whenever there is an extension to the contract time.

Physical Completion Date

The day all of the work is physically completed on the project. All documentation required by the contract and required by law does not necessarily need to be furnished by the Contractor by this date.

Completion Date

The day all the work specified in the contract is completed and all the obligations of the Contractor under the contract are fulfilled by the Contractor. All documentation required by the contract and required by law must be furnished by the Contractor before establishment of this date.

Final Acceptance Date

The date on which the Contracting Agency accepts the work as complete.

Notice of Award (APWA only)

The written notice from the Contracting Agency to the successful bidder signifying the Contracting Agency's acceptance of the bid.

Notice to Proceed (APWA only)

The written notice from the Contracting Agency or Engineer to the Contractor authorizing and directing the Contractor to proceed with the work and establishing the date on which the contract time begins.

SECTION 1-02.1 IS DELETED AND REPLACED BY THE FOLLOWING:

1-02.1 Qualifications of Bidder (APWA only)

Bidders shall be qualified by experience, financing, equipment, and organization to do the work called for in the Contract Documents. The Contracting Agency reserves the right to take whatever action it deems necessary to ascertain the ability of the bidder to perform the work satisfactorily. This action may include a prequalification procedure prior to the bidder being furnished a proposal form on any contract, or a pre-award survey of the bidder's qualifications prior to award.

SECTION 1-02.2 IS DELETED AND REPLACED BY THE FOLLOWING:

1-02.2 Plans and Specifications (APWA only)

Information as to where Bid Documents can be obtained or reviewed will be found in the Call for Bids (Advertisement for Bids) for the work.

After award of the contract, plans and specifications will be issued to the Contractor as detailed in the Special Provisions.

SECTION 1-02.5 IS DELETED AND REPLACED BY THE FOLLOWING:

1-02.5 Proposal Form (APWA only)

At the request of a bidder, the Contracting Agency will provide a proposal form for any project on which the bidder is eligible to bid.

The proposal form will identify the project and its location and describe the work. It will also list estimated quantities, units of measurement, the items of work, and the materials to be furnished at the unit bid prices. The bidder shall complete spaces on the proposal form that call for, but are not limited to, unit prices; extensions; summations; the total bid amount; signatures; date; and, where applicable, retail sales taxes and acknowledgment of addenda; the bidder's name, address, telephone number, and signature; the bidder's D/M/WBE commitment, if applicable; a State of Washington Contractor's Registration Number; and a Business License Number, if applicable. Bids shall be completed by typing or shall be printed in ink by hand, preferably in black ink. The required certifications are included as part of the proposal form.

The Contracting Agency reserves the right to arrange the proposal forms with alternates and additives, if such be to the advantage of the Contracting Agency. The bidder shall bid on all alternates and additives set forth in the proposal forms unless otherwise specified in the Special Provisions.

Any correction to a bid made by interlineation, alteration, or erasure, shall be initialed by the signer of the bid. The bidder shall make no stipulation on the Bid Form, nor qualify the bid in any manner.

A bid by a corporation shall be executed in the corporate name, by the president or a vice president (or other corporate officer accompanied by evidence of authority to sign).

A bid by a partnership shall be executed in the partnership name, and signed by a partner. A copy of the partnership agreement shall be submitted with the Bid Form if any D/M/WBE requirements are to be satisfied through such an agreement.

A bid by a joint venture shall be executed in the joint venture name and signed by a member of the joint venture. A copy of the joint venture agreement shall be submitted with the Bid Form if any D/W/MBE requirements are to be satisfied through such an agreement.

SECTION 1-02.7 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-02.7 Bid Deposit (APWA)

Bid bonds shall contain the following:

1. Contracting Agency-assigned number for the project;
2. Name of the project;
3. The Contracting Agency named as obligee;
4. The amount of the bid bond stated either as a dollar figure or as a percentage which represents five percent of the maximum bid amount that could be awarded;

5. Signature of the bidder's officer empowered to sign official statements. The signature of the person authorized to submit the bid should agree with the signature on the bond, and the title of the person must accompany the said signature;
6. The signature of the surety's officer empowered to sign the bond and the power of attorney.

If so stated in the Contract Provisions, bidder must use the bond form included in the Contract Provisions.

SECTION 1-02.13 PARAGRAPH 1 IS SUPPLEMENTED BY REVISING ITEM (A) IN PARAGRAPH 1 TO READ:

1-02.13 Irregular Proposals (APWA only)

a. The bidder is not prequalified when so required;

SECTION 1-02.14 IS DELETED AND REPLACED BY THE FOLLOWING:

1-02.14 Disqualification of Bidders (APWA only)

A bidder may be deemed not responsible and the proposal rejected if:

1. More than one proposal is submitted for the same project from a bidder under the same or different names;
2. Evidence of collusion exists with any other bidder or potential bidder. Participants in collusion will be restricted from submitting further bids;
3. The bidder, in the opinion of the Contracting Agency, is not qualified for the work or to the full extent of the bid, or to the extent that the bid exceeds the authorized prequalification amount as may have been determined by a prequalification or pre-award evaluation of the bidder;
4. An unsatisfactory performance record exists based on past or current Contracting Agency work or for work done for others, as judged from the standpoint of conduct of the work; workmanship; progress; affirmative action; equal employment opportunity practices; or Disadvantaged Business Enterprise, Minority Business Enterprise, or Women's Business Enterprise utilization;
5. There is uncompleted work (Contracting Agency or otherwise) which might hinder or prevent the prompt completion of the work bid upon;
6. The bidder failed to settle bills for labor or materials on past or current contracts;
7. The bidder has failed to complete a written public contract or has been convicted of a crime arising from a previous public contract;
8. The bidder is unable, financially or otherwise, to perform the work;
9. A bidder is not authorized to do business in the State of Washington (not registered in accordance with RCW 18.27);
10. The bidder fails to meet the D/M/WBE requirements as described in Section 1-02.6
11. There are any other reasons deemed proper by the Contracting Agency.

SECTION 1-02.15 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-02.15 Pre-Award Information (APWA only)

7. Obtain, and furnish a copy of, a business license to do business in the city or county where the work is located.
8. A copy of State of Washington Contractor's Registration.

SECTION 1-03.1 IS SUPPLEMENTED BY REVISING THE LAST SENTENCE IN THE FIRST PARAGRAPH TO READ:

1-03.1 Consideration of Bids (APWA only)

The total of extensions, corrected where necessary, including sales taxes where applicable and such additives and/or alternates as selected by the Contracting Agency, will be used by the Contracting Agency for award purposes and to fix the Awarded Contract Price amount and the amount of the contract bond.

SECTION 1-03.3 IS SUPPLEMENTED BY REVISING SENTENCE 1, PARAGRAPH 1 TO READ:

1-03.3 Execution of Contract (APWA only)

Within 10 calendar days after the award date, or such other time frame identified in the Special Provisions, the successful bidder shall return the signed Contracting Agency-prepared contract, insurance certification as required by Section 1-07.18, and a satisfactory bond as required by law and Section 1-03.4.

SECTION 1-03.3 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-03.3 Execution of Contract (APWA only)

Copies of the Contract Provisions, including the unsigned Form of Contract, will be available for signature by the successful bidder on the first business day following award. The number of copies to be executed by the Contractor will be determined by the Contracting Agency.

SECTION 1-03.4 IS SUPPLEMENTED BY ADDING THE FOLLOWING TO THE FIRST PARAGRAPH:

1-03.4 Contract Bond (APWA only)

5. Be accompanied by a power of attorney for the Surety's officer empowered to sign the bond.
6. Be signed by an officer of the Contractor empowered to sign official statements (sole proprietor or partner). If the Contractor is a corporation, the bond must be signed by the president or vice-president, unless accompanied by written proof of the authority of the individual signing the bond to bind the corporation (i.e., corporate resolution, power of attorney or a letter to such effect by the president or vice-president).

SECTION 1-05.4 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-05.4 Conformity With and Deviations from Plans and Stakes (APWA only)

1-05.4(1) Roadway and Utility Surveys (APWA only)

Unless otherwise specified in the Special Provisions, the Engineer shall furnish to the Contractor one time only all principal lines, grades, and measurements the Engineer deems necessary for completion of the work. These shall generally consist of one initial set of:

1. Slope stakes for establishing grading;
2. Curb grade stakes;
3. Centerline finish grade stakes for pavement sections wider than 7.62 meters; and

4. Offset points to establish line and grade for underground utilities such as water, sewers, and storm drains.

On alley construction projects with minor grade changes, the Engineer shall provide only offset hubs on one side of the alley to establish the alignment and grade, unless otherwise specified in the Special Provisions.

1-05.4(2) Bridge and Structure Surveys (APWA only)

For all structural work such as bridges and retaining walls, the Contractor shall retain as a part of Contractor's organization an experienced team of surveyors.

The Contractor shall provide all surveys required to complete the structure, except the following primary survey control which will be provided by the Engineer:

Centerline or offsets to centerline of the structure.

Stations of abutments and pier centerlines.

A sufficient number of bench marks for levels to enable the Contractor to set grades at reasonably short distances.

Monuments and control points as shown in the Plans.

The Contractor shall establish all secondary survey controls, both horizontal and vertical, as necessary to assure proper placement of all project elements based on the primary control points provided by the Engineer. Survey work shall be within the following tolerances:

Stationing	+3 millimeters
Alignment	+3 millimeters(between successive points)
Superstructure Elevations	+3 millimeters (from plan elevations)
Substructure Elevations	+15 millimeters (from plan elevations)

During the progress of the work, the Contractor shall make available to the Engineer all field books including survey information, footing elevations, cross sections and quantities.

The Contractor shall be fully responsible for the close coordination of field locations and measurements with appropriate dimensions of structural members being fabricated.

SECTION 1-05.7 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-05.7 Removal of Defective and Unauthorized Work (APWA only)

If the Contractor fails to remedy defective or unauthorized work within the time specified in a written notice from the Engineer, or fails to perform any part of the work required by the Contract Documents, the Engineer may correct and remedy such work as may be identified in the written notice, with Contracting Agency forces or by such other means as the Contracting Agency may deem necessary.

If the Contractor fails to comply with a written order to remedy what the Engineer determines to be an emergency situation, the Engineer may have the defective and unauthorized work corrected immediately, have the rejected work removed and replaced, or have work the Contractor refuses to perform completed by using Contracting Agency or other forces. An emergency situation is any situation when, in the opinion of the Engineer, a delay in its remedy could be potentially unsafe, or might cause serious risk of loss or damage to the public.

Direct or indirect costs incurred by the Contracting Agency attributable to correcting and remedying defective or unauthorized work, or work the Contractor failed or refused to perform, shall be paid by the Contractor. Payment will be deducted by the Engineer from monies due, or to become due, the Contractor. Such direct and indirect costs shall include

in particular, but without limitation, compensation for additional professional services required, and costs for repair and replacement of work of others destroyed or damaged by correction, removal, or replacement of the Contractor's unauthorized work.

No adjustment in contract time or compensation will be allowed because of the delay in the performance of the work attributable to the exercise of the Contracting Agency's rights provided by this Section.

The rights exercised under the provisions of this section shall not diminish the Contracting Agency's right to pursue any other avenue for additional remedy or damages with respect to the Contractor's failure to perform the work as required.

SECTION 1-05.11 IS DELETED AND REPLACED BY THE FOLLOWING:

1-05.11 Final Inspection (APWA only)

1-05.11(1) Substantial Completion Date (APWA only)

When the Contractor considers the work to be substantially complete, the Contractor shall so notify the Engineer and request the Engineer establish the Substantial Completion Date. The Contractor's request shall list the specific items of work that remain to be completed in order to reach physical completion. The Engineer will schedule an inspection of the work with the Contractor to determine the status of completion. The Engineer may also establish the Substantial Completion Date unilaterally.

If, after this inspection, the Engineer concurs with the Contractor that the work is substantially complete and ready for its intended use, the Engineer, by written notice to the Contractor, will set the Substantial Completion Date. If, after this inspection the Engineer does not consider the work substantially complete and ready for its intended use, the Engineer will, by written notice, so notify the Contractor giving the reasons therefor.

Upon receipt of written notice concurring in or denying substantial completion, whichever is applicable, the Contractor shall pursue vigorously, diligently and without unauthorized interruption, the work necessary to reach Substantial and Physical Completion. The Contractor shall provide the Engineer with a revised schedule indicating when the Contractor expects to reach substantial and physical completion of the work.

The above process shall be repeated until the Engineer establishes the Substantial Completion Date and the Contractor considers the work physically complete and ready for final inspection.

1-05.11(2) Final Inspection and Physical Completion Date (APWA only)

When the Contractor considers the work physically complete and ready for final inspection, the Contractor by written notice, shall request the Engineer to schedule a final inspection. The Engineer will set a date for final inspection. The Engineer and the Contractor will then make a final inspection and the Engineer will notify the Contractor in writing of all particulars in which the final inspection reveals the work incomplete or unacceptable. The Contractor shall immediately take such corrective measures as are necessary to remedy the listed deficiencies. Corrective work shall be pursued vigorously, diligently, and without interruption until physical completion of the listed deficiencies. This process will continue until the Engineer is satisfied the listed deficiencies have been corrected.

If action to correct the listed deficiencies is not initiated within 7 days after receipt of the written notice listing the deficiencies, the Engineer may, upon written notice to the Contractor, take whatever steps are necessary to correct those deficiencies pursuant to Section 1-05.7.

The Contractor will not be allowed an extension of contract time because of a delay in the performance of the work attributable to the exercise of the Engineer's right hereunder. Upon correction of all deficiencies, the Engineer will notify the Contractor and the Contracting Agency, in writing, of the date upon which the work was considered physically complete. That date shall constitute the Physical Completion Date of the contract, but shall not imply acceptance of the work or that all the obligations of the Contractor under the contract have been fulfilled.

1-05.11(3) Operational Testing (APWA only)

It is the intent of the Contracting Agency to have at the Physical Completion Date a complete and operable system. Therefore when the work involves the installation of machinery or other mechanical equipment; street lighting, electrical distribution or signal systems; irrigation systems; buildings; or other similar work it may be desirable for the Engineer to have the Contractor operate and test the work for a period of time after final inspection but prior to the physical completion date. Whenever items of work are listed in the Contract Provisions for operational testing they shall be fully tested under operating conditions for the time period specified to ensure their acceptability prior to the Physical Completion Date. During and following the test period, the Contractor shall correct any items of workmanship, materials, or equipment which prove faulty, or that are not in first class operating condition. Equipment, electrical controls, meters, or other devices and equipment to be tested during this period shall be tested under the observation of the Engineer, so that the Engineer may determine their suitability for the purpose for which they were installed. The Physical Completion Date cannot be established until testing and corrections have been completed to the satisfaction of the Engineer.

The costs for power, gas, labor, material, supplies, and everything else needed to successfully complete operational testing, shall be included in the unit contract prices related to the system being tested, unless specifically set forth otherwise in the proposal.

Operational and test periods, when required by the Engineer, shall not affect a manufacturer's guaranties or warranties furnished under the terms of the contract.

SECTION 1-05.13 IS SUPPLEMENTED BY REVISING PARAGRAPH 7 TO READ:

1-05.13 Superintendents, Labor, and Equipment of Contractor (APWA only)

Whenever the Contracting Agency evaluates the Contractor's qualifications pursuant to Section 1-02.1, the Contracting Agency will take these performance reports into account.

SECTION 1-05 IS SUPPLEMENTED BY ADDING THE FOLLOWING TWO SECTIONS:

1-05.16 Water and Power (APWA only)

The Contractor shall make necessary arrangements, and shall bear the costs for power and water necessary for the performance of the work, unless the contract includes power and water as a pay item, or unless provided for otherwise in the Special Provisions.

1-05.17 Oral Agreements (APWA only)

No oral agreement or conversation with any officer, agent, or employee of the Contracting Agency, either before or after execution of the contract, shall affect or modify any of the terms or obligations contained in any of the documents comprising the contract.

Such oral agreement or conversation shall be considered as unofficial information and in no way binding upon the Contracting Agency, unless subsequently put in writing and signed by the Contracting Agency.

SECTION 1-07.1 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-07.1 Laws to be Observed (APWA only)

In cases of conflict between different safety regulations, the more stringent regulation shall apply.

The Washington State Department of Labor and Industries shall be the sole and paramount administrative agency responsible for the administration of the provisions of the Washington Industrial Safety and Health Act of 1973 (WISHA).

The Contractor shall maintain at the project site office, or other well known place at the project site, all articles necessary for providing first aid to the injured. The Contractor shall establish, publish, and make known to all employees, procedures for ensuring immediate removal to a hospital, or doctor's care, persons, including employees, who may have been injured on the project site. Employees should not be permitted to work on the project site before the Contractor has established and made known procedures for removal of injured persons to a hospital or a doctor's care.

The Contractor shall have sole responsibility for the safety, efficiency, and adequacy of the Contractor's plant, appliances, and methods, and for any damage or injury resulting from their failure, or improper maintenance, use, or operation. The Contractor shall be solely and completely responsible for the conditions of the project site, including safety for all persons and property in the performance of the work. This requirement shall apply continuously, and not be limited to normal working hours. The required or implied duty of the Engineer to conduct construction review of the Contractor's performance does not, and shall not, be intended to include review and adequacy of the Contractor's safety measures in, on, or near the project site.

SECTION 1-07.2 IS DELETED AND REPLACED BY THE FOLLOWING:

1-07.2 State Sales Tax (APWA only)

1-07.2(1) General (APWA only)

The Washington State Department of Revenue has issued special rules on the State sales tax. Sections 1-07.2(1) through 1-07.2(4) are meant to clarify those rules. The Contractor should contact the Washington State Department of Revenue for answers to questions in this area. The Contracting Agency will not adjust its payment if the Contractor bases a bid on a misunderstood tax liability.

The Contractor shall include all Contractor-paid taxes in the unit bid prices or other contract amounts. In some cases, however, state retail sales tax will not be included.

Section 1-07.2(3) describes this exception.

The Contracting Agency will pay the retained percentage only if the Contractor has obtained from the Washington State Department of Revenue a certificate showing that all contract-related taxes have been paid (RCW 60.28.050). The Contracting Agency may deduct from its payments to the Contractor any amount the Contractor may owe the Washington State Department of Revenue, whether the amount owed relates to this contract or not. Any amount so deducted will be paid into the proper State fund.

1-07.2(2) State Sales Tax — Rule 171 (APWA only)

WAC 458-20-171, and its related rules, apply to building, repairing, or improving streets, roads, etc., which are owned by a municipal corporation, or political subdivision of the state, or by the United States, and which are used primarily for foot or vehicular traffic. This includes storm or combined sewer systems within and included as a part of the street or road drainage system and power lines when such are part of the roadway lighting system. For work performed in such cases, the Contractor shall include Washington State Retail Sales Taxes in the various unit bid item prices, or other contract amounts, including those that the Contractor pays on the purchase of the materials, equipment, or supplies used or consumed in doing the work.

1-07.2(3) State Sales Tax — Rule 170 (APWA only)

WAC 458-20-170, and its related rules, apply to the constructing and repairing of new or existing buildings, or other structures, upon real property. This includes, but is not limited to, the construction of streets, roads, highways, etc., owned by the state of Washington; water mains and their appurtenances; sanitary sewers and sewage disposal systems unless such sewers and disposal systems are within, and a part of, a street or road drainage system; telephone, telegraph, electrical power distribution lines, or other conduits or lines in or above streets or roads, unless such power lines become a part of a street or road lighting system; and installing or attaching of any article of tangible personal property in or to real property, whether or not such personal property becomes a part of the realty by virtue of installation.

For work performed in such cases, the Contractor shall collect from the Contracting Agency, retail sales tax on the full contract price. The Contracting Agency will automatically add this sales tax to each payment to the Contractor. For this reason, the Contractor shall not include the retail sales tax in the unit bid item prices, or in any other contract amount subject to Rule 170, with the following exception.

Exception: The Contracting Agency will not add in sales tax for a payment the Contractor or a subcontractor makes on the purchase or rental of tools, machinery, equipment, or consumable supplies not integrated into the project. Such sales taxes shall be included in the unit bid item prices or in any other contract amount.

1-07.2(4) Services (APWA only)

The Contractor shall not collect retail sales tax from the Contracting Agency on any contract wholly for professional or other services (as defined in Washington State Department of Revenue Rules 138 and 244).

SECTION 1-07.18 IS DELETED AND REPLACED BY THE FOLLOWING:

1-07.18 Public Liability and Property Damage Insurance (APWA only)

General Requirements

The Contractor shall obtain and keep in force during the term of the contract and until 30 days after the physical completion date, unless otherwise indicated below, the following insurance with insurance companies or through sources approved by the State Insurance Commissioner pursuant to Title 48 RCW.

The insurance provided must be with an insurance company with a rating of A-: VII or higher in the A.M. Best's Key Rating Guide, which is licensed to do business in the state of Washington (or issued as a surplus line by a Washington Surplus lines broker). The Contracting Agency reserves the right to approve the security of the insurance provided, the company, terms and coverage, and the Certificate of Insurance.

If any policy is written on a claims made form, the retroactive date shall be prior to or coincident with the effective date of this contract. The policy shall state that coverage is claims made, and state the retroactive date. Claims made form coverage shall be maintained by the Contractor for a minimum of three years following the expiration or earlier termination of this contract, and the Contractor shall annually provide the Contracting Agency with proof of renewal. If renewal of the claims made form of coverage becomes unavailable, or economically prohibitive, the Contractor shall purchase an extended reporting period ("tail") or execute another form of guarantee acceptable to the Contracting Agency to assure financial responsibility for liability for services performed.

The policies of insurance shall contain a "cross liability" endorsement substantially as follows:

> The inclusion of more than one insured under this policy shall not affect the rights of any insured as respects any claim, suit, or judgment made or brought by or for any other insured or by or for any employee of any other insured. This policy shall protect each insured in the same manner as though a separate policy had been issued to each, except that nothing herein shall operate to increase the company's liability beyond the amount or amounts for which the company would have been liable had only one insured been named.

The policies of insurance for general, automobile, and pollution policies shall be specifically endorsed to name the Contracting Agency and its officers, elected officials, employees, agents and volunteers, and any other entity specifically required by the Contract Provisions, as additional insured(s).

In addition, Contractor's insurance shall be primary as respects the Contracting Agency, and any other insurance maintained by the Contracting Agency shall be excess and not contributing insurance with the Contractor's insurance.

The Contracting Agency shall be given at least 45 days prior written notice of any cancellation, reduction in coverage, or other material change in any insurance policy.

Insurance shall provide coverage to the Contractor, all subcontractors, and the Contracting Agency. The coverage shall protect against claims for personal injuries, including accidental death, as well as claims for property damages which may arise from any act or omission of the Contractor or the subcontractor, or by anyone directly or indirectly employed by either of them.

Contractor hereby assumes all risk of damage to its property, or injury to its officers, directors, agents, contractors, or invitees, in or about the Property from any cause, and hereby waives all claims against the Contracting Agency. The Contractor further waives, with respect to the Contracting Agency only, its immunity under RCW Title 51, Industrial Insurance.

Upon request, the Contractor shall forward to the Contracting Agency the original policy, or endorsement obtained, to a Contractor's policy currently in force.

The Contractor shall not begin work under the contract until the required insurance has been obtained and approved by the Contracting Agency.

Failure on the part of the Contractor to maintain the insurance as required shall constitute a material breach of contract upon which the Contracting Agency may, after giving five working days notice to the Contractor to correct the breach, immediately terminate the contract or, at its discretion, procure or renew such insurance and pay any and all premiums in connection therewith, with any sums so expended to be repaid to the Contracting Agency on demand, or at the sole discretion of the Contracting Agency, offset against funds due the Contractor from the Contracting Agency.

All costs for insurance shall be incidental to and included in the unit contract prices of the contract and no additional payment will be made.

Coverages and Limits

The insurance shall provide the minimum coverages and limits set forth below. Providing coverage in these stated minimum limits shall not be construed to relieve the Contractor from liability in excess of such limits. All deductibles must be disclosed and are subject to approval by the Contracting Agency. The cost of any claim payments falling within the deductible shall be the responsibility of the Contractor.

1. A policy of Commercial General Liability Insurance, written on an insurance industry standard occurrence form: (CG 00 01) or equivalent, including all the usual coverage known as:
   Per project aggregate endorsement (CG2503)
   Premises/Operations Liability
   Products/Completed Operations – for a period of one year following final acceptance of the work.
   Personal/Advertising Injury
   Contractual Liability
   Independent Contractors Liability
   Stop Gap or Employers Contingent Liability
   Explosion, Collapse, or Underground (XCU), (as applicable)*
   Liquor Liability/Host Liquor Liability (as applicable)*
   Fire Damage Legal
   Blasting (as applicable)*
   *These coverage are only required when the Contractor's work under this agreement includes exposures to which these specified coverage respond.

If the contract requires working over water, the following additional coverages are required:

a. Watercraft, owned and non-owned
b. U.S. Harborworkers'/Longshoremen and Jones Act

If any structures are involved in the contract, the Contractor shall provide property insurance under an "All Risk Builder's Risk" form in an amount equal to the value of the structure. The structure shall have All Risk Builders Risk Insurance inclusive of earthquake and flood subject to customary industry deductibles.

Other additional coverages that may be required will be listed in the Contract Provisions.

Such policy(ies) must provide the following minimum limits:

Bodily Injury and Property Damage -

$1,000,000	General Aggregate
$1,000,000	Products & Completed Operations Aggregate
$1,000,000	Personal & Advertising Injury

$1,000,000 Each Occurrence
$ 50,000 Fire Damage
Stop Gap Employers Liability
$1,000,000 Each Accident
$1,000,000 Disease - Policy Limit
$1,000,000 Disease - Each Employee

2. Commercial Automobile Liability: as specified by Insurance Services Office, form number CA 0001, Symbol 1 (any auto), with an MCS 90 endorsement and a CA 9948 endorsement attached if "pollutants" as defined in exclusion 11 of the commercial auto policy are to be transported. Such policy(ies) must provide the following minimum limit:
   Bodily Injury and Property Damage -
   $1,000,000 combined single limit
3. Excess or Umbrella Liability
   $1 million per occurrence and aggregate
4. Pollution Liability: A policy providing coverage for claims involving remediation, disposal, or other handling of pollutants arising out of Contractor's operations for others; contractors site (owned); arising from the transportation of hazardous materials; or involving remediation, abatement, repair, maintenance or other work with lead-based paint or materials containing asbestos.
   Such Pollution Liability policy shall provide the following minimum coverage for Bodily Injury and Property Damage:
   $1,000,000 per occurrence
5. Professional Liability: Required if design services are a part of the work, to cover damages resulting from professional errors and omissions. Such policy must provide the following minimum coverage:
   $1,000,000 per claim and annual aggregate
6. A policy of Worker's Compensation, as required by the Industrial Insurance Laws of the State of Washington. As respects Workers' Compensation insurance in the state of Washington, Contractor shall secure its liability for industrial injury to its employees in accordance with the provisions of RCW Title 51. If Contractor is qualified as a self-insurer in accordance with RCW 51.14, Contractor shall so certify by letter signed by a corporate officer indicating that it is a qualified self insured, and setting forth the limits of any policy of excess insurance covering its employees.

Subcontractors

Contractor shall include all subcontractors as insureds under its policies or shall furnish separate evidence of insurance as stated above for each subcontractor. All coverage for subcontractors shall be subject to all the requirements stated herein and applicable to their profession.

Evidence of Insurance

When the Contractor delivers the executed contract for the work to the Contracting Agency it shall be accompanied by a Certificate(s) of Insurance and endorsements for each policy of insurance meeting the requirements set forth above. The certificate must conform to the following requirements:

An ACORD certificate Form 25-S, showing the insuring company, policy effective dates, limits of liability and the Schedule of Forms and Endorsements.

A copy of the endorsement naming Contracting Agency and any other entities required by the Special Provisions as Additional Insured(s), and stating that coverage is primary and non-contributory, showing the policy number, and signed by an authorized representative of the insurance company on Form CG2010 (ISO) or equivalent.

A copy of an endorsement stating that the coverage provided by this policy to the Contracting Agency or any other named insured shall not be canceled, reduced in coverage, or otherwise materially changed without providing at least forty-five (45) days prior written notice to the Contracting Agency.

The certificate(s) shall not contain the following or similar wording regarding cancellation notification to the Contracting Agency: "Failure to mail such notice shall impose no obligation or liability of any kind upon the company."

Self-Insurance

Should Contractor be self-insured for any liability coverage, a letter from the Corporate Risk Manager, or appropriate Finance Officer, is acceptable — stipulating if actuarially funded and fund limits; plus any excess declaration pages to meet the contract requirements. Further, this letter shall advise how Contractor would protect and defend the Contracting Agency as an Additional Insured in their Self-Insured layer, and include claims-handling directions in the event of a claim.

SECTION 1-07.24 IS DELETED AND REPLACED BY THE FOLLOWING:

1-07.24 Rights of Way (APWA only)

Street right of way lines, limits of easements, and limits of construction permits are indicated in the Plans. The Contractor's construction activities shall be confined within these limits, unless arrangements for use of private property are made.

Generally, the Contracting Agency will have obtained, prior to bid opening, all rights of way and easements, both permanent and temporary, necessary for carrying out the work. Exceptions to this are noted in the Bid Documents or will be brought to the Contractor's attention by a duly issued Addendum.

Whenever any of the work is accomplished on or through property other than public right of way, the Contractor shall meet and fulfill all covenants and stipulations of any easement agreement obtained by the Contracting Agency from the owner of the private property. Copies of the easement agreements may be included in the Contract Provisions or made available to the Contractor as soon as practical after they have been obtained by the Engineer.

Whenever easements or rights of entry have not been acquired prior to advertising, these areas are so noted in the Plans. The Contractor shall not proceed with any portion of the work in areas where right of way, easements or rights of entry have not been acquired until the Engineer certifies to the Contractor that the right of way or easement is available or that the right of entry has been received. If the Contractor is delayed due to acts of omission on the part of the Contracting Agency in obtaining easements, rights of entry or right of way, the Contractor will be entitled to an extension of time. The Contractor agrees that such delay shall not be a breach of contract.

Each property owner shall be given 48 hours notice prior to entry by the Contractor. This includes entry onto easements and private property where private improvements must be adjusted.

The Contractor shall be responsible for providing, without expense or liability to the Contracting Agency, any additional land and access thereto that the Contractor may desire for temporary construction facilities, storage of materials, or other Contractor needs. However, before using any private property, whether adjoining the work or not, the Contractor shall file with the Engineer a written permission of the private property owner, and, upon vacating the premises, a written release from the property owner of each property disturbed or otherwise interfered with by reasons of construction pursued under this contract. The statement shall be signed by the private property owner, or proper authority acting for the owner of the private property affected, stating that permission has been granted to use the property and all necessary permits have been obtained or, in the case of a release, that the restoration of the property has been satisfactorily accomplished. The statement shall include the parcel number, address, and date of signature. Written releases must be filed with the Engineer before the Completion Date will be established.

SECTION 1-08 IS SUPPLEMENTED BY ADDING THE FOLLOWING:

1-08.0 Preliminary Matters (APWA only)

1-08.0(1) Preconstruction Conference (APWA only)

Prior to the Contractor beginning the work, a preconstruction conference will be held between the Contractor, the Engineer and such other interested parties as may be invited. The purpose of the preconstruction conference will be:

To review the initial progress schedule;
To establish a working understanding among the various parties associated or affected by the work;
To establish and review procedures for progress payment, notifications, approvals, submittals, etc.;
To establish normal working hours for the work;
To review safety standards and traffic control; and
To discuss such other related items as may be pertinent to the work.

The Contractor shall prepare and submit at the preconstruction meeting the following:

A breakdown of all lump sum items;
A preliminary schedule of working drawing submittals; and
A list of material sources for approval if applicable.

1-08.0(2) Hours of Work (APWA only)

Except in the case of emergency or unless otherwise stated in the Special Provisions or approved by the Contracting Agency, the normal straight time working hours for the contract shall be any consecutive 8-hour period between 7:00 a.m. and 6:00 p.m. of a working day with a maximum 1-hour lunch break and a 5-day work week. The normal straight time 8-hour working period for the contract shall be established at the preconstruction conference or prior to the Contractor commencing the work.

If a Contractor desires to perform work on holidays, Saturdays, Sundays, or before 7:00 a.m. or after 6:00 p.m. on any day, the Contractor shall apply in writing to the Engineer for permission to work such times. Permission to work longer than an 8-hour period between 7:00 a.m. and 6:00 p.m. is not required. Such requests shall be submitted to the Engineer no later than noon on the working day prior to the day for which the Contractor is requesting permission to work.

Permission to work between the hours of 10:00 p.m. and 7:00 a.m. during weekdays and between the hours of 10:00 p.m. and 9:00 a.m. on weekends or holidays may also be subject to noise control requirements. Approval to continue work during these hours may be revoked at any time the Contractor exceeds the Contracting Agency's noise control regulations or complaints are received from the public or adjoining property owners regarding the noise from the Contractor's operations. The Contractor shall have no claim for damages or delays should such permission be revoked for these reasons.

Permission to work Saturdays, Sundays, holidays or other than the agreed upon normal straight time working hours Monday through Friday may be given subject to certain other conditions set forth by the Contracting Agency or Engineer. These conditions may include but are not limited to: requiring the Engineer or such assistants as the Engineer may deem necessary to be present during the work; requiring the Contractor to reimburse the Contracting Agency for the costs in excess of straight-time costs for Contracting Agency employees who worked during such times, on non Federal aid projects; considering the work performed on Saturdays and holidays as working days with regards to the contract time; and considering multiple work shifts as multiple working days with respect to contract time even though the multiple shifts occur in a single 24-hour period. Assistants may include, but are not limited to, survey crews; personnel from the Contracting Agency's material testing lab; inspectors; and other Contracting Agency employees when in the opinion of the Engineer, such work necessitates their presence.

1-08.0(3) Reimbursement for Overtime Work of Contracting Agency Employees (non Federal aid projects only) (APWA only)

Where the Contractor elects to work on a Saturday, Sunday, or holiday, or longer than an 8-hour work shift on a regular working day, as defined in the Standard Specifications, such work shall be considered as overtime work. On all such overtime work an inspector will be present, and a survey crew may be required at the discretion of the Engineer. In such case, the Contracting Agency may deduct from amounts due or to become due to the Contractor for the costs in excess of the straight-time costs for employees of the Contracting Agency required to work overtime hours.

The Contractor by these specifications does hereby authorize the Engineer to deduct such costs from the amount due or to become due to the Contractor.

SECTION 1-08.1 IS SUPPLEMENTED BY REVISING THE SECOND SENTENCE OF THE SEVENTH PARAGRAPH TO READ:

1-08.1 Subcontracting (APWA only)

This certification shall be submitted to the Engineer, on the form provided by the Engineer, annually on the date cited in the Special Provisions, or 20 calendar days after physical completion of the contract, whichever comes first.

SECTION 1-08.4 IS REVISED BY DELETING THE FIRST SENTENCE AND REPLACING IT WITH THE FOLLOWING:

1-08.4 Notice to Proceed and Prosecution of the Work (APWA only)

Notice to Proceed will be given after the contract has been executed and the contract bond and evidence of insurance have been approved and filed by the Contracting Agency. The Contractor shall not commence with the work until the Notice to Proceed has been

given by the Engineer. The Contractor shall commence construction activities on the project site within ten days of the Notice to Proceed Date, unless otherwise approved in writing.

SECTION 1-08.5 IS SUPPLEMENTED BY ADDING THE FOLLOWING TO THE END OF THE FIFTH PARAGRAPH:

1-08.5 Time for Completion (APWA Only)

If the Contractor elects to work 10 hours a day and 4 days a week (a 4-10 schedule) and the fifth day of the week in which a 4-10 shift is worked would ordinarily be charged as a working day then the fifth day of that week will be charged as a working day whether or not the Contractor works on that day.

SECTION 1-08.5 IS SUPPLEMENTED BY ADDING THE FOLLOWING TO ITEM 2 OF THE LAST PARAGRAPH:

1-08.5 Time for Completion (APWA Only)

g. Property owner releases per Section 1-07.24

SECTION 1-09.9 IS REVISED BY DELETING THE THIRD PARAGRAPH AND REPLACING IT WITH THE FOLLOWING:

1-09.9 Payments (APWA only)

Progress payments for completed work and material on hand will be based upon progress estimates prepared by the Engineer. A progress estimate cutoff date will be established at the preconstruction meeting.

The initial progress estimate will be made not later than 30 days after the Contractor commences the work, and successive progress estimates will be made every month thereafter until the Completion Date. Progress estimates made during progress of the work are tentative, and made only for the purpose of determining progress payment. The progress estimates are subject to change at any time prior to the calculation of the Final Payment.

The value of the progress estimate will be the sum of the following:

Unit Price Items in the Bid Form — the approximate quantity of acceptable units of work completed multiplied by the unit price.

Lump Sum Items in the Bid Form — the estimated percentage complete multiplied by the Bid Forms amount for each Lump Sum Item, or per the schedule of values for that item.

Materials on Hand — 100 percent of invoiced cost of material delivered to Job site or other storage area approved by the Engineer.

Change Orders — entitlement for approved extra cost or completed extra work as determined by the Engineer.

Progress payments will be made in accordance with the progress estimate less:

Retainage per Section 1-04.8.

The amount of Progress Payments previously made.

Funds withheld by the Contracting Agency for disbursement in accordance with the Contract Documents.

Progress payments for work performed shall not be evidence of acceptable performance or an admission by the Contracting Agency that any work has been satisfactorily completed.

Payments will be made by warrants, issued by the Contracting Agency's fiscal officer, against the appropriate fund source for the project. Payments received on account of work performed by a subcontractor are subject to the provisions of RCW 39.04.250.

SECTION 1-09.13(3)A IS SUPPLEMENTED BY REVISING THE FIRST SENTENCE OF THE THIRD PARAGRAPH TO READ: THAT JUDGMENT MAY BE ENTERED IN THE SUPERIOR COURT OF THE COUNTY IN WHICH CONTRACTING AGENCY'S HEADQUARTERS ARE LOCATED.

SECTION 1-10.5, THE BID ITEM "TRAFFIC CONTROL LABOR" IN THE SECOND PARAGRAPH IS DELETED AND REPLACED WITH THE FOLLOWING:

1-10.5 Payment (APWA Only)

"Traffic Control Labor", per hour (Min. Bid $_____ per hour)

The unit contract price per hour, at the minimum price or more stated in the bid form, shall be full pay for all costs for the labor provided for performing those construction operations described in Section 1-10.3(1) and as authorized by the Engineer. Payment under this item shall be limited to the hours the worker is actually performing the work.

Should the Contractor determine that the cost for this work is greater than the minimum price shown in the bid form, the Contractor may bid a higher price. Should the Contractor write in a unit price less than the minimum price shown in the bid form, the minimum unit price shown in the bid form shall govern and become part of the bid.

DIVISION 2
EARTHWORK

2-01 CLEARING, GRUBBING, AND ROADSIDE CLEANUP

2-01.1 Description

The Contractor shall clear, grub, and clean up those areas staked or described in the Special Provisions. This work includes protecting from harm all trees, bushes, shrubs, or other objects selected to remain.

"Clearing" means removing and disposing of all unwanted material from the surface, such as trees, brush, down timber, or other natural material.

"Grubbing" means removing and disposing of all unwanted vegetative matter from underground, such as sod, stumps, roots, buried logs, or other debris.

"Roadside cleanup", whether inside or outside the staked area, means work done to give the roadside an attractive, finished appearance.

"Debris" means all nonusable natural material produced by clearing, grubbing, or roadside cleanup.

2-01.2 Disposal of Usable Material and Debris

When possible, the Contractor should sell all usable material such as timber, chips, or firewood produced by clearing, grubbing, or roadside cleanup. The Contractor shall not allow the public to fell trees.

The Contractor shall meet all requirements of state, county, and municipal regulations regarding health, safety, and public welfare in the disposal of all debris.

The Contractor shall dispose of all debris by one or more of the three disposal methods described below.

Disposal of debris in a Contractor-provided waste site shall meet the requirements of Section 2-03.3(7)C.

2-01.2(1) Disposal Method No. 1 — Open Burning

The open burning of residue resulting from land clearing is restricted by Chapter 173-425 of the Washington Administrative Code. No commercial open burning shall be conducted without authorization from the Washington State Department of Ecology or the appropriate local air pollution control authority.

Open burning, when permitted, shall be done in a high stack that meets these requirements:

1. Diameter — at least 6 meters.
2. Height — one meter or more for every meter of diameter.
3. Content — clean debris, with stumps free of excess dirt, stacked in well-ventilated piles.
4. Stacking equipment — debris must be stacked and the fire maintained by clamshell or similar equipment, not by bulldozer or front-end loader.
5. Number of stacks — no more than one fire every 200 meters may be burning at one time.
6. Additional debris shall not be added to a burning stack.

2-01.2(2) Disposal Method No. 2 — Waste Site

Debris shall be hauled to a waste site obtained and provided by the Contractor in accordance with Section 2-03.3(7)C.

2-01.2(3) Disposal Method No. 3 — Chipping

Chipping shall be done by machines that can grind debris into wood chips. Wood chips to be sold may be any size. Unsold chips shall be no larger than 4000 square millimeters and no thicker than 13 millimeters. The Contractor shall spread unsold chips evenly on the project site and tractor-walk them into the ground.

Stumps shall be hauled to a waste site obtained by the Contractor.

2-01.3 Construction Requirements

2-01.3(1) Clearing

The Contractor shall:

1. Complete the clearing work at least 1 kilometer ahead of grading.
2. Fell trees only within the area to be cleared.
3. Close-cut parallel to the slope of the ground all stumps to be left in the cleared area outside the slope stakes.
4. Close cut all stumps that will be buried by fills 1.5 meters or less in depth.
5. Follow these requirements for all stumps that will be buried by fills deeper than 1.5 meters:
   a. Close-cut stumps under 0.5 meter in diameter.
   b. Trim stumps that exceed 0.5 meter in diameter to no more than 0.25 meter above original ground level.
6. Leave standing any trees or native growth indicated by the Engineer.
7. Trim all trees to be left standing to the height specified by the Engineer, neatly cutting all limbs close to the tree trunk.
8. Thin clumps of native growth as the Engineer may direct.
9. Protect, by fencing if necessary, all trees or native growth from any damage caused by construction operations.

2-01.3(2) Grubbing

The Contractor shall:

1. Complete the grubbing work at least 300 meters ahead of grading.
2. Grub deep enough to remove all stumps, large roots, buried logs, and other vegetative material.
3. Grub all areas:
   a. Indicated by the Engineer or by the Special Provisions.
   b. To be excavated, including area staked for slope treatment.
   c. Where subdrainage trenches will be dug, unsuitable material removed, or structures built.
   d. In which hillsides or existing embankments will be terraced as described in Section 2-03.3(14).
   e. Upon which embankments will be placed, except where the subgrade or slope elevation exceeds 1.5 meters above the natural ground surface, the Contractor may close cut all trees, stumps, and large roots under 0.5 meter in diameter.

A contract may include grubbing without mentioning clearing or roadside cleanup. In that case, the Contractor shall remove and dispose of all upturned stumps and roots of windfalls that lie within the cleared area of the right of way, even though they are outside the area staked for grubbing. Such work shall be incidental to other work covered by the Contract.

2-01.3(3) Vacant

2-01.3(4) Roadside Cleanup

Roadside cleanup, as directed by the Engineer, consists of work not otherwise provided for in the Contract. Such work may include:

1. Removing trees, snags, down timber, upturned stumps, large rocks and boulders, and other unsightly matter outside the areas staked for clearing or grubbing.
2. Thinning trees or brush.
3. Filling holes and smoothing and contouring the ground.
4. Shaping the ends of cuts and fills to fit adjacent terrain and to enhance the area's appearance.
5. Obliterating abandoned roads and reshaping the areas to blend naturally with surroundings.

Methods and equipment used in roadside cleanup shall be approved by the Engineer.

2-01.4 Measurement

No unit of measurement shall apply to the lump sum price for clearing and grubbing.

When clearing and grubbing is paid per hectare, the following areas will be excluded from measurement:

1. Any area along an existing highway that requires no work.
2. Any gap that requires no work, provided the gap is at least 15 meters long when measured parallel to the center line and contains at least 200 square meters.

Isolated areas of less than 200 square meters that require work lying between areas excluded from measurement will be counted as having 200 square meters. If these isolated areas occur intermittently, the final measurement shall not exceed the total area containing the several isolated areas when measured as continuous.

Clearing and grubbing may be combined in the proposal. If the proposal calls for such combined work to be measured "per acre," the measurement methods described above will apply. If the proposal designates such combined work as "lump sum," the Department will not base payment on any unit of measurement.

2-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Clearing and Grubbing", per hectare or lump sum.

The unit contract price per hectare or lump sum for "Clearing and Gubbing" shall be full pay for all work described in this section, except "Roadside Cleanup".

"Roadside Cleanup", by force account as provided in Section 1-09.6.

To provide a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the Contractor's total bid.

2-02 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

2-02.1 Description

The work described in this section includes removing and disposing of, or salvaging, materials named in the Special Provisions or identified by the Engineer. The work also includes the backfilling of trenches, holes, or pits that result from such removal.

2-02.2 Vacant

2-02.3 Construction Requirements

With certain exceptions, the Contractor shall raze, remove, and dispose of all buildings and foundations, structures, fences, and other obstructions that lie wholly or partially within the right of way. The exceptions are utility-owned equipment and any other items the Contracting Agency may direct the Contractor to leave intact.

When salvageable material is to remain Contracting Agency property, the Special Provisions will identify the material and describe how the Contractor shall remove it and where it will be stored.

Any material not named in the Special Provisions as Contracting Agency property will become the property of the Contractor and shall be removed from the project.

The Contractor may dispose of waste material in Contracting Agency owned sites if the Special Provisions or the Engineer permit it. Otherwise, the Contractor shall arrange to dispose of waste at no expense to the Contracting Agency and the disposal shall meet the requirements of Section 2-03.3(7)C.

2-02.3(1) Removal of Foundations

When remvoing foundations the Contractor shall:

1. Remove foundations to a depth of at least 1.5 meters below finished ground elevation or subgrade elevation, whichever is lower.
2. Break up basement floors to promote drainage.
3. Fill basements or other cavities left by the removal of structures. The fill shall match the level of surrounding ground. Fill within the slopes of the roadbed shall be compacted to meet the requirements of Section 2-03.3(14)C, Method B.

2-02.3(2) Removal of Bridges, Box Culverts, and other Drainage Structures

When salvaging any steel or wooden bridge that will remain Contracting Agency property, the Contractor shall prevent unnecessary damage to the material. Steel members shall be match-marked.

Unless otherwise directed, the Contractor shall remove foundations of existing structures to a point 0.6 meter below: the finished ground elevation, the adjacent ground elevation, or the natural stream bottom. If a foundation lies wholly or partially on the site of a new structure, it shall be removed to a level that accommodates building the new structure.

Any blasting shall be subject to the Engineer's approval. The Contractor must complete all blasting before the placement of new work.

2-02.3(3) Removal of Pavement, Sidewalks, and Curbs

In removing pavement, sidewalks, and curbs, the Contractor shall:

1. Haul broken-up pieces into the roadway embankment or to some off-project site.
2. Make a vetical saw cut between any existing pavement, sidewalk, or curb that is to remain and the portion to be removed.
3. Replace at no expense to the Contracting Agency any existing pavement designated to remain that is damaged during the removal of other pavement.

2-02.4 Vacant

2-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Removal of Structure and Obstruction", lump sum.

If pavements, sidewalks, or curbs lie within an excavation area, their removal will be paid for as part of the quantity removed in excavation.

2-03 ROADWAY EXCAVATION AND EMBANKMENT

2-03.1 Description

The work described in this section, regardless of the nature or type of the materials encountered, includes excavating and grading the roadway, excavating in borrow pits, excavating below grade, excavating channels, removing slide material, and disposing of all excavated material. These activities may be performed in making cuts, embankments, slopes, roadway ditches, approaches, parking areas, highway-driveway intersections, and in completing related work.

The work excludes these items if they are designated as pay items in the Contract:

1. Haul.
2. Excavation for structures and ditches.
3. Removal of unsuitable materials.

The Plans may divide the project into separate areas (Roadway Excavation, Area A, Roadway Excavation, Area B, etc.). Such division does not imply any classification of materials in the areas. The boundaries of the areas shall not be changed regardless of how similar or dissimilar the materials are from one area to another.

All work described here must reasonably conform to the alignment, grade, and cross-sections shown in the Plans or established by the Engineer.

2-03.2 Vacant

2-03.3 Construction Requirements

2-03.3(1) Widening of Cuts

If routine cuts do not supply enough material to form the embankment, the Contractor shall obtain more fill from cuts inside or outside the right of way as the Engineer may direct or from widening one or both sides of existing cuts as designated by the Engineer. In either case, the Contractor shall dress the sides of the cuts to any slopes the Engineer may require. If the Contractor has dressed a cut before the Engineer orders it widened, the Contracting Agency will pay for the resloping as provided in Section 1-04.4.

2-03.3(2) Rock Cuts

Preserving Rock Below Subgrade. The Contractor shall take care not to break down, loosen, or damage the rock under the subgrade line, except as provided by Section 2-03.3(3). Normally cuts will be made from the top, lift by lift, to protect the rock bench that will remain. The Contractor shall be responsible for methods used and for any damage caused to the roadbed, regardless of any previous approvals by the Engineer.

Scaling and Dressing. To leave rock cuts in a safe, stable condition, the Contractor shall scale and dress them, removing all loose fragments and rocks not firmly fastened to the rock slope. The Contractor shall also remove any overhanging rock the Engineer sees as a hazard to roadway users.

If the Engineer requires it, the Contractor shall remove loose fragments and rocks lying outside the slope stakes. Payment for such extra work shall be by force account as provided in Section 1-09.6. The Contracting Agency will pay for loading and hauling these materials at the unit contract prices that apply or as provided in Section 1-04.4.

Controlled Blasting. When blasting to establish slopes 2 to 1 or steeper, and more than 3 meters high, the Contractor shall use controlled blasting. The Engineer may require the Contractor to use controlled blasting to form the faces of other slopes, even if the slopes could be formed by nonblasting methods.

Controlled blasting refers to the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to provide a free surface or shear plane in the rock along the specified backslope. Controlled blasting techniques covered by this specification include presplitting and cushion blasting.

Not less than two weeks prior to commencing drilling and blasting operations or at any time the Contractor proposes to change the drilling and blasting methods, the Contractor shall submit a blasting plan to the Engineer for review. The blasting plan shall contain the full details of the drilling and blasting patterns and controls the Contractor proposes to use for both the controlled and production blasting. The blasting plan shall contain the following minimum information:

1. Station limits of proposed shot.
2. Plan and section views of proposed drill pattern including free face, burden, blasthole spacing, blasthole diameter, blasthole angles, lift height, and subdrill depth.
3. Loading diagram showing type and amount of explosives, primers, initiators, and location and depth of stemming.
4. Initiation sequence of blastholes including delay times and delay system.
5. Manufacturer's data sheets for all explosives, primers, and initiators to be employed.

Review of the blast plan by the Engineer shall not relieve the Contractor of the responsibility for the accuracy and adequacy of the plan when implemented in the field.

When using control blasting the Contractor shall:

1. Prior to commencing full-scale blasting operations, the Contractor shall demonstrate the adequacy of the proposed blast plan by drilling, blasting, and excavating short test sections, up to 30 meters in length, to determine which combination of method, hole spacing, and charge works best. When field conditions warrant, the Contractor may be ordered to use test section lengths less than 30 meters.

   Unless otherwise approved by the Engineer, the Contractor shall begin the tests with the controlled blast holes spaced 0.75 meter apart, then adjust if needed, until the Engineer approves the spacing to be used for full-scale blasting operations.
2. The Contractor shall completely remove all overburden soil and loose or decomposed rock along the top of the excavation for a distance of at least 10 meters beyond the end of the production hole drilling limits, or to the end of the cut, before drilling the presplitting holes.
3. The controlled blast holes shall be not less than 60 millimeters nor more than 80 millimeters in diameter.
4. The Contractor shall control drilling operations by the use of the proper equipment and technique to ensure that no hole shall deviate from the plane of the planned slope by more than 250 millimeters either parallel or normal to the slope. Drill holes exceeding these limits shall not be paid for unless satisfactory slopes are being obtained.
5. Controlled blast holes shall extend a minimum of 10 meters beyond the limits of the production holes to be detonated, or to the end of the cut as applicable.
6. The length of controlled blast holes for any individual lift shall not exceed 6 meters unless the Contractor can demonstrate to the Engineer the ability to stay within the above tolerances and produce a uniform slope. If greater than 5 percent

of the presplit holes are misaligned in any one lift, the Contractor shall reduce the height of the lifts until the 250-millimeter alignment tolerance is met. Upon satisfactory demonstration, the length of holes may be increased to a maximum of 18 meters with written approval of the Engineer.

7. When the cut height requires more than one lift, a maximum 0.5-meter offset between lifts will be permitted to allow for drill equipment clearances. The Contractor shall begin the control blast hole drilling at a point which will allow for necessary offsets and shall adjust, at the start of lower lifts, to compensate for any drift which may have occurred in the upper lifts.
8. Before placing charges, the Contractor shall determine that the hole is free of obstructions for its entire depth. All necessary precautions shall be exercised so that the placing of the charges will not cause caving of material from the walls of the holes.
9. The maximum diameter of explosives used in presplit holes shall not be greater than 1/2 the diameter of the presplit hole.
10. Only standard explosives manufactured especially for controlled blasting shall be used in controlled blast holes, unless otherwise approved by the Engineer. Bulk ammonium nitrate and fuel oil (ANFO) shall not be allowed to be loaded in the presplit holes.

    If fractional portions of standard explosive cartridges are used, they shall be firmly affixed to the detonating cord in a manner that the cartridges will not slip down the detonating cord nor bridge across the hole. Spacing of fractional cartridges along the length of the detonating cord shall not exceed 0.75 meter center to center and shall be adjusted to give the desired results.

    Continuous column cartridge type of explosives used with detonating cord shall be assembled and affixed to the detonating cord in accordance with the explosive manufacturer's instructions, a copy of which shall be furnished to the Engineer.
11. The bottom charge of a presplit hole may be larger than the line charges but shall not be large enough to cause overbreak. The top charge of the presplitting hole shall be placed far enough below the collar, and reduced sufficiently, to avoid overbreaking and heaving.
12. The upper portion of all presplit holes, from the top most charge to the hole collar, shall be stemmed. Stemming materials shall be sand or other dry angular material, all of which passes a 9.5-millimeter sieve.
13. If presplitting is specified, the detonation of these holes shall be fired first.
14. If cushion blasting is specified, the detonation of these holes shall be fired last on an instantaneous delay after all other blasting has taken place in the excavation.
15. Production blast holes shall not be drilled closer than 2 meters to the controlled blast line, unless approved by the Engineer. The bottom of the production holes shall not be lower than the bottom of the controlled blast holes. Production holes shall not exceed 150 millimeters in diameter, unless approved by the Engineer. Detonation of production holes shall be on a delay sequence toward a free face.
16. The use of horizontal blast holes for either production or controlled blasting is prohibited.

2-03.3(3) Excavation Below Grade

Rock Excavation. When the Contractor finds rock or other hard material at the subgrade elevation, it shall be excavated the full width of the roadbed to at least 150 millimeters below subgrade, then backfilled with rock fragments, gravel, or other free-draining material not more than 100 millimeters in diameter.

If the Contractor uses a subgrade trimmer, the backfill shall be rock, gravel, or other free-draining material not more than 50 millimeters in diameter. The Contractor shall save the finer free-draining material from excavations or borrow pits to use in backfilling the top 150 millimeters of the subgrade. All such material shall be approved by the Engineer.

Subexcavation. At any time, the Engineer may order excavation below subgrade to remove soft and uncompactible material. The replacement material shall be free-draining and granular, or other materials as determined by the Engineer.

Draining Rock Pockets. If blasting below subgrade leaves a rock pocket that will not drain, the Contractor shall dig a trench from the pocket bottom to the roadside ditch, then backfill both the pocket and the trench with rock fragments, gravel, or other material approved by the Engineer, at no expense to the Contracting Agency.

Compaction. If the density of the natural earth under any area of the roadway is less than that required in Section 2-03.3(14)C, Method B, the Engineer may direct the Contractor to:

1. Scarify the earth to a depth of 150 millimeters.
2. Aerate or water.
3. Compact the scarified area to the required density.
4. Excavate to a specific depth.
5. Backfill the excavated area in layers, using the previously excavated material or other material.
6. Compact each layer to meet the compaction requirements for embankments.

2-03.3(4) Sluicing

The Contractor shall not excavate by sluicing unless the Special Provisions specifically call for it.

2-03.3(5) Slope Treatment

The tops of all roadway cut slopes, except solid rock cuts, shall be rounded in accordance with the Standard Plan. Unless otherwise noted in the Plans or Special Provisions, Class A slope treatment shall be utilized.

If a layer of earth covers a rock cut, the slope shall be rounded above the rock as if it were an earth slope.

When the Contractor removes stumps or any embedded material from the rounded area, the void shall be backfilled and stabilized to prevent erosion.

All work required to complete slope treatment, including excavation, haul, and slope rounding, shall be included in the unit bid price for roadway excavation.

2-03.3(6) Deposit of Rock for the Contracting Agency's Use

At the Engineer's direction, the Contractor shall deposit excavated rock at the roadside or elsewhere. If this requires the Contractor to use material that would otherwise have gone into an embankment, the Contracting Agency will pay for the extra cubic meters of excavation needed to complete the embankment. Any such rock deposit shall be Contracting Agency property. The Contractor shall be responsible for safekeeping the deposit until the Contracting Agency has removed it or until the contract is completed.

2-03.3(7) Disposal of Surplus Material

2-03.3(7)A General

The Contractor shall haul all excavation to the nearest embankment unless the Engineer declares the hauling distance to be too great. If excavation yields more material than needed for nearby embankments, the Contractor shall dispose of the excess in keeping with the Special Provisions or as the Engineer directs.

2-03.3(7)B Haul

When the contract includes a payment item for haul, the Contracting Agency will pay as follows for hauling excess excavation to a disposal site:

1. If the Contracting Agency provides a site, but the Contractor chooses to haul elsewhere, the Contracting Agency will pay for the actual distance up to but not exceeding the distance that would have been necessary using the Contracting Agency site.
2. If the Contracting Agency does not provide a site, the Contracting Agency will pay for the actual distance up to but not exceeding the distance necessary to haul to a site 1.6 kilometers from the project limits.

2-03.3(7)C Contractor-Provided Disposal Site

If the Contracting Agency provides no waste site, but requires disposal of excess excavation or other materials, the Contractor shall arrange for disposal at no expense to the Contracting Agency, except as provided in Section 2-03.3(7)B, Item 2.

The Contractor shall acquire all permits and approvals required for the use of the disposal site. The cost of any such permits and approvals shall be included in the bid prices for other work.

The Contractor shall provide the Engineer the location of all disposal sites to be used and also provide copies of the permits and approvals for such disposal sites before any waste is hauled off the project.

Disposal of excess material within a wetland area will not be allowed without a Section 404 permit issued by the U.S. Corps of Engineers and approval by the local agency with jurisdiction over the wetlands. Wetlands are defined as those areas inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The Contractor shall protect, indemnify, and save harmless the Contracting Agency from any damages that may arise from the Contractor's activities in making these arrangements. Such indemnity shall be in accordance with RCW 4.24.115 as amended by CH. 305, Laws of 1986. Any action required to satisfy any permit and/or any approval requirements in a Contractor provided disposal site shall be performed by the Contractor at no additional expense to the Contracting Agency.

Reclamation of a Contractor-supplied waste site must conform to the requirements of Section 3-03.

2-03.3(8) Wasting Material

If, against the Engineer's orders, the Contractor wastes material needed for the embankment, it shall be replaced at no expense to the Contracting Agency with material the Engineer approves.

2-03.3(9) Roadway Ditches

At each transition from cut to fill, the Contractor shall divert any roadway ditch away from the embankment in natural ground. Ditches shall never permit water to flow into or upon embankment material.

2-03.3(10) Selected Material

When the contract or the Engineer calls for it, selected material shall be used for finishing the top part of the subgrade, for structural or other backfill, or for other purposes. Unless the Special Provisions specify otherwise, the Engineer may identify as "selected" any material excavated within the right-of-way, including the excavation of local borrow.

Direct Hauling. If it is practical, the Contractor shall haul selected material immediately from excavation to its final place on the roadbed. The Contracting Agency will pay for such work at the unit contract prices for excavating, hauling, watering, and compacting.

Delayed Excavation. If it is impractical to haul selected material to its final place at once, the Contractor shall delay excavation until the placement will be workable. The Contracting Agency will not pay extra for delayed excavation.

Stockpiling. The Engineer may allow the Contractor to stockpile selected materials if delaying the excavation will hamper grading or force impractical movements of equipment. In this case, the Engineer will direct where and when the Contractor shall excavate, stockpile, haul, and place the selected materials.

Sections 2-03.4 and 2-03.5 describe how the Contracting Agency will measure and pay for excavating and hauling these stockpiled selected materials. The neat line volume of material removed will provide the basis for measuring material taken from the stockpile.

2-03.3(11) Slides

If a slide occurs on a finished slope before final acceptance of the work, the Contractor shall remove or replace the slide material. The Contractor shall also refinish the slope to the condition and with the materials required by the Engineer.

The Contracting Agency will pay for the excavation at the unit contract price and for resloping on a force account basis. The Engineer may authorize payment for the excavation by agreed price or force account if:

1. The slide material cannot be measured accurately; or
2. Excavation of slide material requires equipment not available on the project.

If the Contractor undercuts or destroys a slope, it shall be resloped to the original alignment or to a new one established by the Engineer at no expense to the Contracting Agency.

2-03.3(12) Overbreak

Overbreak includes that part of any material excavated, displaced, or loosened outside the staked or reestablished slope or grade. Such material is considered overbreak whether its movement resulted from blasting, from the character of the material itself, or from any other cause. Overbreak, however, does not include material from slides as described in Section 2-03.3(11).

If the Engineer does not approve use of the overbreak, the Contractor shall remove, haul, and dispose of it at no expense to the Contracting Agency. In this case, the Contractor shall follow the procedure for handling surplus described in Section 2-03.3(7).

If the Engineer approves, the Contractor may use overbreak:

1. To complete an embankment when the excavated material unexpectedly falls short of the amount required. The Contracting Agency will pay the roadway excavation contract price for the volume of material the overbreak replaces, and will pay the contract price for haul. However, no payment will be made if overbreak is used when other material is available within the neat lines of the roadway prism.
2. To replace borrow excavation originally planned for an embankment. The Contracting Agency will pay for overbreak used this way at the unit contract price for roadway or borrow excavation, whichever costs less. The Engineer will include haul to be paid as in the original proposal in comparing the costs under the two payment methods.

2-03.3(13) Borrow

Borrow is the excavation of material outside the roadway prism or outside the limits of any other excavation area required by the contract. Before any borrow site can be used, it must be measured and approved by the Engineer. Any material excavated from a borrow site before the site is measured will not be paid for. The widening of roadway cuts and ditches will be considered roadway excavation, not borrow.

If the contract documents designate borrow sources, the Contractor may utilize those sources or may obtain borrow from other sites. If borrow is obtained from a Contractor-provided site, there will be no additional cost to the Contracting Agency beyond the contract unit price for the excavated borrow material. There will be no payment for aeration of the borrowed material from a Contractor-provided site, even if the contract contains an item for aeration and even if the contract documents designate borrow sources.

If neither the Plans nor the Special Provisions name a source for borrow, the Contractor shall provide a source at no expense to the Contracting Agency.

The Contractor shall reclaim all borrow sites, Contracting Agency-owned, Contracting Agency-supplied, or obtained by the Contractor, in keeping with Section 3-03.

2-03.3(14) Embankment Construction

The Contracting Agency classifies embankment construction as:

1. Rock embankment — in which the material in all or any part of an embankment contains 25 percent or more, by volume, gravel or stone 100 millimeters or more in diameter. Section 2-03.3(14)A.
2. Earth embankment — made of any material other than that used in rock embankment. Section 2-03.3(14)B.

Unstable Base. If the Engineer believes the natural earth base will impair an embankment or make it unstable, the Contractor shall stabilize or remove and dispose of the base material in keeping with this section or Section 2-03.3(14)E.

Hillside Terraces. Unless the Engineer directs otherwise, the Contractor shall terrace the original ground or embankment on hillsides, on the sides of existing embankments, and in transitions from cuts to fills. Each terrace shall penetrate the slope at least 1.5 meters and shall not be more than 1.5 meters high. The horizontal face of the terrace shall slope outward at approximately 50 millimeters per meter. The Engineer may order the Contractor to place gravel backfill, pipe drains or both to drain any seepage.

All costs for building terraces shall be included in the prices for other work.

Soft Base. On wet or swampy ground, the Contractor shall haul and spread embankment material by methods that will disturb the base as little as possible. If the Engineer approves, the Contractor may place the lower part of the fill by dumping and spreading successive loads to form a uniform layer just thick enough to support equipment used to place and compact upper layers.

Normally the Contractor shall not increase the planned depth of the embankment over a soft base merely to permit the use of heavier equipment. But if the Contractor proves that the planned depth will not support light hauling vehicles, the Engineer may approve a deeper fill. The Contractor shall not claim extra pay if these restrictions require the use of lighter equipment or different construction methods than originally planned for use on the soft base.

2-03.3(14)A Rock Embankment Construction

The Contractor shall build rock embankments in horizontal layers. No layer shall be deeper than 0.5 meter unless the rocks in the fill material average more than 0.5 meter in diameter. The Contractor shall separate and distribute the larger pieces of rock and fill the spaces between them with smaller rocks and earth. With the Engineer's approval, the Contractor may dispose of rocks larger than the average size instead of placing them in the embankment.

Compacting. The Contractor shall use a 45-tonne compression roller or a vibratory roller having a dynamic force of at least 178 kilonewtons impact per vibration and at least 1,000 vibrations per minute. In either case, the roller shall make one full coverage for each 150 millimeters, or any fraction of 150 millimeters, of lift depth.

When lift depth is 0.5 meter or less, the Contractor may use a 9-tonne compression roller or a vibratory roller having a dynamic force of at least 134 kilonewtons impact per vibration and at least 1,000 vibrations per minute. In either case, the roller shall make four full coverages for each 150 millimeters, or any fraction of 150 millimeters, of lift depth.

Rollers must exert reasonably even pressure over the area covered. The Contractor shall limit the speed of compression rollers to no more than 1.75 meters per second, and the speed of vibratory rollers to no more than 0.7 meter per second.

If possible, the Contractor shall compact the material even further by routing empty and loaded hauling equipment evenly over the entire width of the embankment.

When the Engineer believes rolling to be physically impractical, rolling may be omitted on part or all of a layer.

Should excessive moisture threaten the stability of the embankment the Engineer may order the Contractor to alter the operation. This may include alternating layers of wet and dry materials, drying materials before placing, or halting work in the problem areas. In this case the Contracting Agency will not increase payment, but will pay the unit contract prices for the pay items that apply.

Top Layer. The Contractor shall build each rock embankment up to 150 millimeters below subgrade. The top 150-millimeters layer of embankment shall be of rock, gravel, or other free-draining material that does not exceed 100 millimeters in diameter. When the Plans require use of a subgrade trimmer, these materials in the top layer may not exceed 50 millimeters in diameter.

When practical, and as approved by the Engineer, the Contractor shall save the finer free-draining material from excavations or borrow pits for use in topping rock fills. If selected materials suitable for topping are available, the Contracting Agency will pay for them as described in Section 2-03.3(10). If such materials are not available on site, the

Contracting Agency will pay for imported materials by including them in the unit contract price for gravel borrow or borrow excavation, each including haul. If the proposal does not include these items, the Contracting Agency will pay as provided in Section 1-04.4.

2-03.3(14)B Earth Embankment Construction

The Contractor shall place earth embankments in horizontal layers of uniform thickness. These layers shall run full width from the top to the bottom of the embankment. Slopes shall be compacted to the required density as part of embankment compaction.

During grading operations, the Contractor shall shape the surfaces of embankments and excavations to uniform cross-sections and eliminate all ruts and low places that could hold water. The Contractor shall raise the center of an embankment above the sides. When the surface of an embankment intersects a side hill, the surface shall be sloped away at a rate not to exceed 1:20.

2-03.3(14)C Compacting Earth Embankments

This section describes three methods (A, B, and C) for building earth embankments. The Contractor shall use Method B unless the Special Provisions require another method.

Method A. Each embankment shall be made of layers no more than 0.5 meter thick. The Contractor shall compact each layer by routing loaded haul equipment over its entire width. If the Engineer approves, the Contractor may use end dumping to begin placing a sidehill fill too narrow for hauling equipment. When the fill is wide enough, the remaining layers shall be compacted by the loaded hauling equipment.

Method B. The top 0.5 meter of each embankment shall be compacted to 95 percent of the maximum density as determined by the compaction control tests described in Section 2-03.3(14)D. All material below the 0.5-meter level shall be compacted to 90 percent of the same maximum density.

In the top 0.5 meter, horizontal layers shall not exceed 100 millimeters in depth before compaction. No layer below the top 0.5 meter shall exceed 200 millimeters in depth before compaction.

The Contractor shall use compacting equipment approved by the Engineer.

Method C. Each layer of the entire embankment shall be compacted to 95 percent of the maximum density as determined by the compaction control tests described in Section 2-03.3(14)D.

In the top 0.5 meter, horizontal layers shall not exceed 100 millimeters in depth before compaction. No layer below the top 0.5 meter shall exceed 200 millimeters in depth before compaction.

The Contractor shall use compacting equipment approved by the Engineer.

Under Methods B or C, the Engineer may permit the Contractor to increase layer thickness up to 450 millimeters before compaction, provided:

1. The layer is more than 0.5 meters below the top of the embankment,
2. An approved vibratory roller is used, and
3. The required density is obtained throughout the full depth and width of each layer.

Whatever the method used, any embankment inaccessible to large compacting equipment shall be compacted with small mechanical or vibratory compactors.

Moisture Content. Within the limits described below, the Contractor shall adjust moisture content during compaction to produce a firm, stable embankment. The Contractor shall not begin compaction until the moisture content is so adjusted.

Under Method B, the moisture content of the material shall not exceed 3 percent above the optimum determined by the tests described in Section 2-03.3(14)D. If the material contains too little moisture to compact properly, the Engineer may order the Contractor to water the material in specific amounts. In this case, the Contracting Agency will pay the unit contract price for water (Section 2-07).

Under Method C, the moisture content shall not vary more than 3 percent above or below optimum determined by the tests described in Section 2-03.3(14)D.

The Engineer may permit the Contractor to place materials having a higher moisture content than specified in this section if:

1. The material consists of free-draining rock, gravel, or sand that produces a firm, stable embankment; and
2. The excess moisture will not impair the embankment.

However, the Engineer may at any time require the Contractor to return to normal moisture-content specifications.

The Contracting Agency will consider all costs of drying embankment material to be incidental to other work. If, however, the Contract includes an aeration item, the Contracting Agency will pay for such work as specified in Sections 2-03.4 and 2-03.5.

If weather prevents drying excavation or borrow materials to the required moisture content, the Engineer may order the Contractor to alter normal procedures or equipment to prevent damage to the partial or complete embankment. In this case, the Contracting Agency will not increase payment, but will pay the unit contract prices for the pay items that apply.

The Contractor shall repair at no expense to the Contracting Agency any partial or complete embankment that loses stability because of continued hauling across it. Evidence of lost stability shall include pumping or rutting. The Contractor shall also alter hauling equipment or procedures to prevent further damage.

If it appears that rain or snow will soak an area that has been aerated, the Contractor shall temporarily seal it against the weather. Should the Contractor fail to do so, any additional aeration required to restore the area to its previous condition shall be done at no expense to the Contracting Agency.

2-03.3(14)D Compaction and Moisture Control Tests

Maximum density for materials with 30 percent or more, by mass retained on the 4.75 mm sieve shall be determined using WSDOT Test Method No. 606. The maximum density and optimum moisture for materials with less than 30 percent, by mass, retained on the 4.75 mm sieve shall be determined using AASHTO T 99 Method A.

In place density and moisture content will be determined using WSDOT Test Method No. 613.

2-03.3(14)E Unsuitable Foundation Excavation

When the contract or the Engineer requires it, the Contractor shall excavate unstable natural ground before building any embankment over it. This unstable material may include peat, muck, swampland, buried logs and stumps, or other material not fit for an embankment base. The Contractor shall excavate such material to the boundaries set by the Engineer.

The work will not be considered unsuitable foundation excavation if the materials:

1. Came from the roadway cut, ditch, or channel-change prisms.
2. Resulted from structure excavation Class A or B.
3. Are covered in Section 2-03.3(3).

If the Contract provides no bid item for unsuitable foundation excavation, the Contracting Agency will pay as provided in Section 1-04.4.

2-03.3(14)F Displacement of Unsuitable Foundation Materials

If the Contract requires it, the Contractor shall displace or remove any overburden of peat, muck, or other unstable material to permit placing the embankment on underlying firm ground. The Engineer will determine the elevation at which the ground is firm enough to support the embankment.

To displace such material, the Contractor shall use explosives or any other method the Engineer requires. If this work upheaves overburden material outside the slopes of the new fill, the Contractor shall level the material to make it presentable.

The Contracting Agency will pay for the work described in this section by force account. Any other costs related to the work shall be incidental to building the embankment and shall be included in the unit contract prices for the work items that apply.

2-03.3(14)G Backfilling

When water fills an area after the removal of soft or unstable materials, the Contractor shall, if possible, drain the site so that any backfill may be compacted. If drainage is not possible, the Contractor shall use granular material for backfilling in water, including areas where blasting has displaced the soft material. The Special Provisions may require other backfilling methods.

The costs of pumping or digging temporary drainage ditches shall be incidental to and included in other items of work that apply.

2-03.3(14)H Prefabricated Vertical Drains

The Contractor shall furnish all necessary labor, equipment and materials, and perform all operations necessary for the installation of prefabricated vertical drains in accordance with the details shown in the Plans and with the requirements of these Specifications.

The prefabricated drain shall consist of a continuous plastic drainage core wrapped in a nonwoven geotextile material as specified in the Contract.

The drains shall be free of defects, rips, holes, or flaws. During shipment and storage, the drain shall be wrapped in a heavy duty protective covering. The storage area shall protect the drain material from sunlight, mud, dirt, dust, debris, and detrimental substances. Manufacturer certification shall be provided for all drain materials delivered to the project.

Vertical drains shall be staked by the Contractor and constructed prior to embankment construction.

Prior to installation of vertical drains, a sand drainage blanket shall be placed on the ground surface for use as a working platform. This platform shall have a minimum depth of 0.6 meter and shall consist of uncompacted material meeting the requirements of Section 9-03.13(1).

Vertical drains shall be installed with equipment which will cause a minimum of subsoil disturbance. A mandrel or sleeve shall be advanced through the subsoil using vibratory, constant load, or constant rate of advance methods. The mandrel shall have a maximum cross-sectional area of 9000 square millimeters, shall protect the prefabricated drain material from tears, cuts, and abrasions during installation, and shall be provided with an “anchor” plate or rod. The “anchor” plate or rod shall provide sufficient strength to

prevent the soil from entering the bottom during installation and shall anchor the bottom of the drain at the required depth when the mandrel is removed. Use of falling weight impact hammers or jetting will not be allowed within the compressible subsoil to be drained.

The prefabricated drains shall be installed vertically from the working surface to the required elevations and in a sequence that will not require equipment to travel over previously installed drains. The Contractor shall provide the Engineer with a suitable means of verifying the plumbness of the equipment and determining the depth of the drain at any time. The equipment shall not deviate more than 20 millimeters per meter from vertical.

Splices or connections in the prefabricated drain material shall be done in a professional manner to ensure continuity of the wick material. The prefabricated drain shall be cut to leave at least 150 millimeters protruding above the working platform at each drain location.

Where obstructions are encountered which cannot be penetrated the Contractor shall abandon the hole. A maximum of two attempts shall be made to install a new drain within 0.5 meter of the obstructed hole. Drains that otherwise deviate from the plan location by more than 150 millimeters, or that are damaged or improperly installed, will be rejected.

Installation of the drains should consider and be coordinated with the geotechnical instrumentation shown in the Plans. Special care shall be taken when installing drains near instrumentation already in place. Replacement of instrumentation damaged by the Contractor will be the responsibility of the Contractor.

The Contractor shall demonstrate that the equipment, method, and materials produce a satisfactory installation in accordance with these Specifications. For this purpose, the Contractor shall be required to install trial drains at different locations within the work area.

At least two weeks prior to the installation of the drainage wicks, the Contractor shall submit to the Engineer, for review and approval, details of the sequence and method of installation. The submittal shall, at a minimum, contain the dimensions and length of mandrel, a detailed description of the proposed method(s) for overcoming obstructions, and the proposed method(s) for splicing drains.

Approval by the Engineer will not relieve the Contractor of the responsibility to install prefabricated vertical drains in accordance with the Plans, Special Provisions, and these Specifications. If, at any time, the Engineer considers the method of installation does not produce a satisfactory drain, the Contractor shall alter the method and equipment as necessary.

2-03.3(14)I Embankments at Bridge and Trestle Ends

This work consists of filling around the ends of trestles and bridges, the area defined in Section 1-01.3. The Contractor shall begin and complete this work as soon as possible after each bridge is completed or when the Engineer requires.

The Contractor shall select fill material from the excavation sources elsewhere on the project. Bridge approach embankments shall be compacted to at least 95 percent of the maximum density as determined by the tests described in Section 2-03.3(14)D. In any embankment area where piles will be installed, the Contractor shall remove all solid material, rocks, broken concrete, etc., larger than 75 millimeters across that would interfere with pile driving.

To prevent the bridge from being distorted or displaced, the Contractor shall place backfill material evenly around all sides and parts of the structure. The Contractor shall not backfill any abutment prior to placing the superstructure. After the superstructure is in place, use of small compactors may be required to compact the backfill around the structure.

Embankments and backfill behind the abutments must be brought up in layers and compacted concurrently. The difference in backfill height against each abutment shall not exceed 0.6 meter unless approved by the Engineer.

The Contractor may request, in writing, approval to place the abutment backfill (either full or partial height) prior to placement of the superstructure. To receive this approval, the Contractor shall submit calculations, for the Engineer's review. The calculations shall prove that the abutment is stable, both for overturning and sliding, without the superstructure in place. The stability calculations shall assume a loading of 4.7 kN/m^3 equivalent fluid pressure and include at least a 0.6 meter surcharge for the backfill placement equipment. If the abutment backfill is allowed to be placed prior to completion of the superstructure, the Contractor shall bear any added cost that results from the change.

The Contractor shall build the embankment under the bridge to the dimensions shown in the Standard Plans or detailed in the Plans.

Cost related to all work described in this section shall be incidental to other work and included in the unit contract prices that apply.

2-03.3(14)J Gravel Borrow Including Haul

When required by the Plans or the Engineer, the Contractor shall use gravel borrow meeting the requirements of Section 9-03.14(1) to:

1. Build structural embankments.
2. Backfill excavation of unsuitable foundation material above the ground water table.
3. Backfill below-grade excavation above the ground water table.
4. Construct mechanically stabilized earth walls.
5. Construct reinforced soil slopes.

Gravel borrow shall be compacted according to Section 2-03.3(14)C and 2-03.3(14)D.

2-03.3(14)K Select or Common Borrow Including Haul

When required by the Plans or the Engineer, the Contractor shall use select borrow meeting the requirements of Section 9-03.14(2), or common borrow meeting the requirements of Section 9-03.14(3) to:

1. Build embankments.
2. Backfill excavation of unsuitable foundation material above the ground water table.
3. Backfill below-grade excavation above the ground water table.

Where specified, select borrow may be used for constructing reinforced slopes.

Select borrow and common borrow shall be compacted according to Section 2-03.3(14)C and 2-03.3(14)D.

2-03.3(14)L Embankment Widening for Guardrail

Embankments widened for the installation of beam guardrail shall be terraced. Each terrace shall penetrate the slope 0.5 meters and shall not be more than 1.5 meters high. Compaction shall be in accordance with Method A, as specified in Section 2-03.3(14)C. Guardrail posts shall not be installed until the embankment widening is completed and compacted.

2-03.3(14)M Excavation of Channels

Excavation of channels includes all ditches 2.5 or more meters wide at the bottom.

Before excavating, the Contractor shall clear and grub the area in accordance with Section 2-01.

2-03.3(15) Aeration

The Contracting Agency may include aeration as a contract item if material from test holes in excavation or borrow sites is too wet to compact properly. Even if the Contract includes such an item, the Contractor shall make every effort to reduce the need for aeration. The Contractor shall do so by using methods known to be effective in building embankments with wet materials. Such methods include open ditching to drain excavation areas or alternating layers of wet and dry materials. These and similar methods will be incidental to excavation and their costs shall be included in the unit contract price for roadway excavation, for borrow excavation (including haul), and for haul.

If aeration is not a contract item, its cost shall be incidental to and included in the excavation and embankment items.

Aeration Equipment. The Engineer may direct the Contractor to use aeration equipment in these areas: roadway excavation, borrow sites, or embankments. The Contracting Agency does not guarantee the moisture-reducing effectiveness of any single type of equipment. The Engineer may, however, require the use of any type which will best aerate a given area.

If the Contractor uses any of the following types of equipment, it shall meet these minimum requirements:

1. Heavy duty power grader. This machine shall have a moldboard measuring 3.65 meters long, 0.6 meter high, and 19 millimeters thick. Each grader shall carry its maximum number of standard scarifier-rippers or discs.
2. Heavy duty gang plow. It shall have at least five 0.4-meter bottoms. Its tractor shall be able to move no less than 0.7 meter per second while plowing at least 230 millimeters deep through fairly wet material.
3. Heavy duty tandem discs. This machine shall cut a swath at least 2.4 meters wide with discs no less than 0.66 meter in diameter. Its tractor shall be able to turn fairly wet material at least 150 millimeters deep while moving at 0.9 meter per second or more.
4. Heavy duty self-propelled, rotary pulverizer. This machine shall have paddles attached to a transverse shaft. It shall travel 0.7 meter per second or more while aerating a swath at least 1.8 meters wide to a depth of 150 millimeters.

The Contractor shall not use any aerating equipment listed above in tandem nor use any of this equipment to carry out other bid items of work while aerating.

The Engineer may halt aerating work when weather conditions prevent satisfactory results.

2-03.3(16) End Slopes

The Engineer will determine when and where to build end slopes, whether these occur at the beginning or end of a project, at the borders of excavation or embankments, at bridge ends, or elsewhere. The Contractor shall build end slopes not detailed in the Plans to the line and grade designated by the Engineer regardless of center line limits shown in the Plans. All work to complete and maintain these end slopes shall be considered as work to be performed under the Contract.

2-03.3(17) Snow Removal

If snow deep enough to interfere with the work covers a cut or an embankment, the Contractor shall remove and deposit it outside the slope stakes. Snow removal must be done at least 30 meters ahead of excavation and embankment work. The Contractor shall remove snow at no expense to the Contracting Agency.

2-03.3(18) Stepped Slope Construction

When the Plans or the Engineer requires it, the Contractor shall shape slopes cut in soft rock to a stepped pattern conforming closely to the typical cross-section in the Plans. Stepped slopes shall meet these requirements:

1. Each step shall be 0.3 to 0.6 meter high.
2. The horizontal depth of each step will depend on its relationship to the staked slope ratio. The approximate midpoint of each horizontal tread shall occur on the staked slope line.
3. The treads shall be approximately level in all directions.
4. The ends of the steps shall be blended into the natural ground, with loose material removed from transitional areas.
5. If the Contractor cannot rip a rock outcropping within a cut, the steps shall be blended into the rock.
6. Large rocks and material that may fall into the ditch line or onto the roadway shall be removed, but scaling is not required.

The compaction and seeding requirements of Section 8-01.3(1)B shall not apply to stepped slope construction.

The Contracting Agency will measure stepped slope excavation by the area defined by the staked slope line. The unit contract price per cubic meter for roadway or borrow excavation shall be full pay for all labor and equipment required to build stepped slopes.

2-03.4 Measurement

The Contracting Agency will use the following methods to measure work performed unless specific exceptions in other sections provide otherwise:

1. Roadway excavation, unsuitable foundation excavation, and common borrow — by the cubic meter. Material will be measured in its original position by cross-sectioning or through the use of digital terrain modeling survey techniques. In roadway excavation, pay quantities will be computed to the neat lines of the cross-sections as staked. When the Contracting Agency requires excavated material to be removed, stockpiled, and moved again, the material will be measured to the neat line of that removed from the stockpile. In this case, the measurement and payment provisions of Sections 2-04.4 and 2-04.5 shall apply.
2. Controlled blasting of rock faces — by the meter of hole drilled. Holes will be measured from the top of the rock surface to the elevation of the roadway ditch or to a bench elevation set by the Engineer.
3. Prefabricated vertical drain — by the meter. Measurement will be measured from the top of the working platform to the bottom of each hole. Trial drains will be measured in the same manner as production drains.
4. Sand drainage blanket — by the tonne. Moisture above 8 percent will be deducted from pay quantities.
5. Embankment compaction (except under Method A) — by the cubic meter. Material will be measured to the neat lines of the staked cross-sections of compacted embankment. No allowance will be made for material that settles. No deduction will be taken for other items constructed within the embankment (bridge abutments, piers, columns, backfill, pipes, etc.). The Contracting Agency will exclude from compaction measurement material that is wasted or placed under water and not compacted in layers as provided by Sections 2-03.3(14)A and 2-03.3(14)C. In cuts and excavation below grade, compaction will be

measured by the cubic meter in the cross-section of compacted backfill material. When material in cuts or below grade is scarified and recompacted, it will be measured by its compacted depth, up to a maximum of 150 millimeters.

6. Gravel borrow and select borrow — by the tonne or cubic meter. Measurement by cubic meter will be made in the hauling vehicle at the point of delivery on the roadway.
7. Aeration — by the hour (to the nearest 1/2 hour). Hours actually spent aerating material. The following will be excluded from aeration time:
   a. Time spent by supervisors or foremen directing the work.
   b. Time taken to move equipment from and to different locations on the project site.
   c. Time spent repairing equipment.
   d. Time equipment is idle or on standby.
   e. Time equipment is doing nonaeration work. The Contracting Agency will include time for one move-in and one move-out if a piece of equipment outside the project limits is required for aeration.

2-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Roadway Excavation" or "Roadway Excavation — Area A (B, C, etc.)", per cubic meter.

When the Engineer orders excavation below subgrade, unit contract prices shall apply, unless the work and/or the equipment to perform the work differs materially from the excavation above subgrade, then payment will be in accordance with Section 1-04.4.

The unit contract price per cubic meter shall be full pay for excavating, loading, placing, or otherwise disposing of the material. For haul, the unit contract price as provided in Section 2-04 shall apply, except when the pay item is shown as including haul. In that case the unit contract price per cubic meter shall include haul.

"Common Borrow Incl. Haul", per cubic meter.

The unit contract price per cubic meter for "Common Borrow Incl. Haul" shall be full pay for excavating, loading, hauling, placing, or otherwise disposing of the material. This price includes pay for removing from the surface of a borrow site, disposing of, wasting, or stockpiling any material not suitable for embankment.

"Unsuitable Foundation Excavation", per cubic meter.

The unit contract price per cubic meter for "Unsuitable Foundation Excavation" shall be full pay for excavating, loading, and disposing of the material. For haul, the unit contract price as provided in Section 2-04 shall apply, except when the bid item is shown as including haul. In that case, the unit contract price per cubic meter shall include haul.

"Controlled Blasting of Rock Face", per meter.

Quantities shown in the Plans are based on 0.76-meter hole spacing. Actual quantities will depend on field conditions and results from test sections.

Measurement and payment for roadway excavation and haul related to blasting shall be as provided under those items in this section and shall include the volume of material excavated from the benches or setbacks approved for drilling separate lifts.

"Prefabricated Vertical Drain", per meter.

"Sand Drainage Blanket", per tonne.

Compaction will be paid for by the item "Embankment Compaction."

"Embankment Compaction", per cubic meter.

The unit contract price per cubic meter for "Embankment Compaction" shall be full pay for all material, labor, tools, equipment, and incidentals required. The quantities for embankment compaction shown in the proposal are estimates only. The Engineer will be the sole judge of the actual quantities needed.

When embankments are made by Method A, payment for embankment compaction will not be made as a separate item. All costs for embankment compaction shall be included in other bid items involved.

"Select Borrow Incl. Haul", per tonne or per cubic meter.

Unless otherwise provided, the work described in Section 2-03.3(14), Embankment Construction, shall be incidental to other pay items involved.

"Gravel Borrow Incl. Haul", per tonne or per cubic meter.

Compaction will be paid for by the item "Embankment Compaction."

"Aeration", by force account.

Payment for aeration equipment shall be made according to the current AGC-Washington Contracting Agency Department of Transportation Equipment Rental Agreement.

The payment for aeration and other related unit contract prices shall be full pay for all costs incidental to aeration, including temporary sealing of aerated embankments for protection against the elements, intermittent operation and for furnishing and operating the equipment assemblies and for all related supplies and labor to perform the work specified. Should the Contractor fail to seal an aerated area prior to inclement weather, additional aeration to restore the area to its previous condition shall be at the Contractor's expense.

To provide a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

2-04 HAUL

2-04.1 Description

This work consists of transporting excavated material from its original site to its final place in the work.

The balance points shown in the Plans are only approximate. The Engineer may change the balance points to help equalize quantities of materials or to dispose of surpluses.

When the Plans require hauling, the Contractor shall not substitute wasting or borrowing. The Contracting Agency will not pay extra for cross-hauling unless the Engineer so orders.

2-04.2 Vacant

2-04.3 Vacant

2-04.4 Measurement

The Contracting Agency will measure haul in units of haul where one unit equals 100 cubic meters of excavated material hauled 100 meters.

Excavated material will be measured in its original position. The Engineer will provide a copy of the location mass diagram upon request.

Haul On Right of Way. To compute units of haul, the Contracting Agency will measure haul distance parallel to the center line (or base line) of the highway. Lateral distance (cross-hauling) will not be measured.

Quantities to be measured in this way include: (1) material from the roadway prism or prisms, (2) borrow from widened cuts, (3) waste deposited in the right of way or alongside it, and (4) material from auxiliary lanes — frontage roads, speed change lanes, paralleling and loop ramps, cross roads, and other lanes that supplement through-traffic movements.

If the Plans show more than one center line or base line (as in a multi-lane highway), the Plans or Special Provisions will describe the line by which haul will be computed.

Waste Haul Off Right of Way. The Contracting Agency will measure the cross-section and length of any waste embankment to calculate waste quantities. If the Plans or Special Provisions do not specify a haul route, the Contracting Agency will compute haul along the long axis of the waste embankment, thence along a line running perpendicular to the highway center line, starting at the center line and ending at the nearest end of the waste embankment.

However, when a route is specified, haul distance will be measured along that route. If the Contractor chooses to use a route shorter than that computed or specified, the Contracting Agency will base payment on the length of the route actually used.

2-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Haul", per unit.

2-06 SUBGRADE PREPARATION

2-06.1 Description

This work consists of preparing graded roadbed for surfacing or surfaced roadbed for paving.

2-06.2 Vacant

2-06.3 Construction Requirements

2-06.3(1) Subgrade for Surfacing

In preparing the roadbed for surfacing, the Contractor shall:

1. Remove from the roadbed, immediately before placing surfacing materials, all brush, weeds, vegetation, grass, and other debris.
2. Dispose of all debris as the Engineer directs.
3. Drain water from all low spots or ruts.
4. Shape the entire subgrade to a uniform surface running reasonably true to the line, grade, and cross-section as staked.
5. If necessary, the Contractor shall process the subgrade in cut areas to remove materials too coarse for mechanical trimming and recompaction.
6. Compact the subgrade to a depth of 150 millimeters. Compaction shall achieve 95 percent of the maximum density determined under the tests described in Section 2-03.3(14)D. If the underlying material is too soft to permit proper compaction of the subgrade, the Contractor shall loosen, aerate (or excavate and remove), and compact the subgrade until the top layer can be compacted as required.
7. Remove excess material that does not drift to low spots during blading and shaping. The Contractor shall dispose of this excess by placing it where the subgrade lacks material or by wasting it, as the Engineer directs.
8. Add materials as the Engineer directs where the subgrade needs more to bring it up to grade. The Contractor shall water and compact these added materials as needed to produce a true finished subgrade.

If the contract requires a trimming machine, it shall:

1. Maintain the grade and transverse slopes automatically through sensors that respond to reference lines on both edges of each roadway.
2. Create a smooth, uniform surface free from chatter and ripples.

2-06.3(2) Subgrade for Pavement

Before any paving is placed, the Contractor shall bring the subgrade to the required line, grade, and cross-section. The Contractor shall compact the subgrade to a depth of 150 millimeters to 95 percent standard density as determined by the compaction control tests for granular materials. The compacted area shall be wide enough to let paving machines operate without visible distortion of surfacing material.

The Contractor shall maintain the subgrade in the required condition until the pavement is placed. The Contractor may remove material just before paving if the Plans require thicker areas of pavement.

2-06.4 Vacant

2-06.5 Measurement and Payment

2-06.5(1) Subgrade Constructed Under Same Contract

Surfacing or Treated Base. If the Contractor builds a subgrade for surfacing or treated base, the Contracting Agency will consider subgrade preparation as part of the construction work. In this case, measurement and payment will conform to Section 2-03. Such payment shall be the full price for all subgrade preparation work.

Pavement. If the Contractor builds a subgrade for pavement, the Contracting Agency will follow the criteria in Section 5-04 (for asphalt concrete pavement) or Section 5-05 (for cement concrete pavement) to measure and pay for materials used to prepare the subgrade. The Contracting Agency will measure and pay for water as specified in Section 2-07.

2-06.5(2) Subgrade Not Constructed Under Same Contract

When the Contractor prepares an existing subgrade for surfacing (one not built under the present contract), the Contracting Agency will measure and pay for the work by these criteria:

1. **Final Conditioning.** All the following work on the subgrade shall be included in other contract bid items: clearing vegetation and other debris, draining water, smoothing to prepare for staking, blading, shaping, and compacting to a 150-millimeter depth to final line, grade, and cross-section.
2. **Excess Materials.** If the Contractor must dispose of excess materials during blading and shaping, the Contracting Agency will measure and pay for the work as roadway excavation. If the contract includes no pay item for roadway excavation, the Contracting Agency will measure and pay as provided in Section 1-04.4.
3. **Added Materials.** If the subgrade requires more materials, the Contracting Agency will pay the unit contract price for each kind of material the Contractor provides. The unit contract price shall be full pay for furnishing, placing, and compacting the materials. When unit contract prices do not apply, the Contracting Agency will measure and pay for the work as provided in Section 1-04.4.
4. **Excavation and Backfill.** If the Engineer orders the Contractor to excavate unstable spots in the subgrade, the Contracting Agency will measure and pay for the work as roadway excavation. If the contract does not include roadway excavation as a pay item, payment will be by agreed price or force account. The Contracting Agency will pay unit contract prices for suitable backfill material when included in the contract and will pay as provided in Section 1-04.4 when not included.
5. **Subgrade Protection.** No payment shall be made for protecting the subgrade.

2-07 WATERING

2-07.1 Description

This work consists of furnishing, hauling, and applying water for compacting embankments, constructing subgrade, placing of crushed surfacing, dust control, and as the Engineer requires.

2-07.2 Vacant

2-07.3 Construction Requirements

The Contractor shall apply water by means of tank trucks equipped with spray bars. Spray controls shall ensure that the water flows evenly and in the amounts required by the Engineer. The Engineer may direct that the Contractor apply water at night or early in the morning to reduce evaporation losses.

2-07.4 Measurement

Water shall be measured by tanks or tank trucks of known capacity or by meters approved by the Engineer. The Contractor shall supply and install any meters at no expense to the Contracting Agency.

2-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Water", per cubic meter.

The unit contract price per cubic meter for "water" shall be full pay for all labor, materials, tools, and equipment necessary to furnish, haul, and apply the water.

When the contract does not include water as a pay item, providing and applying the water shall be incidental to construction. All costs shall be included in the other contract pay items.

2-09 STRUCTURE EXCAVATION

2-09.1 Description

Structure excavation consists of excavating and disposing of all natural material or man-made objects that must be removed to make way for bridge foundations, retaining walls, culverts, trenches for pipelines, conduits, and other structures as shown in the Plans.

This work also includes, unless the contract provides otherwise, removing whole or partial structures, grubbing structure sites that would not otherwise be grubbed, building and later removing shoring, cofferdams, or caissons, pumping or draining excavated areas, protecting excavated materials from the weather, and placing and compacting backfill.

2-09.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Fine Aggregate for Portland Cement Concrete	9-03.1(2)
Admixture for Concrete	9-23.6
Fly Ash	9-23.9
Water	9-25

2-09.3 Construction Requirements

2-09.3(1) General Requirements

All structure excavation, trenching, and shoring shall be performed in strict compliance with Chapter 296-155 WAC as well as all other applicable local, Contracting Agency, and Federal laws and regulations.

2-09.3(1)A Staking, Cross-Sectioning, and Inspecting

The Contractor shall not begin excavating until after the stakes have been set to locate and/or outline the structure and taken cross-sections to determine how much material to remove. The Engineer will occasionally inspect material taken from and material remaining in the excavation.

2-09.3(1)B Depth of Excavation

The Contractor shall excavate foundation pits to the depth the Plans require, or to any revised depth ordered by the Engineer.

2-09.3(1)C Removal of Unstable Base Material

When the material at the bottom of an excavation is not stable enough to support the structure, the Contractor shall excavate below grade and replace the unstable material with gravel backfill.

Gravel backfill shall meet the requirements of Section 9-03.12. It shall be placed in layers not more than 150 millimeters thick with each layer compacted to 95 percent of the maximum density determined by the Compaction Control Test, Section 2-03.3(14)D.

2-09.3(1)D Disposal of Excavated Material

The Engineer may direct the Contractor to dispose of excavated material in embankments, backfills, or remove it from the site.

All costs for disposing of excavated material within the project limits shall be included in the unit contract price for structure excavation, Class A or B. If, however, the Contractor must load and haul the material to a disposal site, the Contracting Agency will pay as provided in Section 1-04.4 for loading and hauling. The Contracting Agency will not pay for handling at the disposal site. Any such disposal shall meet the requirements of Section 2-03.3(7)C.

If the contract includes structure excavation, Class A or B, including haul, the unit contract price shall include all costs for loading and hauling the material the full required distance.

2-09.3(1)E Backfilling

The backfilling of openings dug for structures shall be a necessary part of and incidental to the excavation. Unless the Engineer directs otherwise, backfill material shall be nonclay material containing no pieces more than 75 millimeters across, no frozen lumps, and no wood or other foreign material.

When specified in the contract or when approved by the Engineer, the Contractor shall supply controlled density fill as backfill material.

Alternative Sources. When material from structure excavation is unsuitable for use as backfill, the Engineer may: require the Contractor to use other material covered by the contract if such substitution involves work that does not differ materially from what would otherwise have been required; require the Contractor to substitute selected material in accordance with Section 2-03.3(10); require the Contractor to use controlled density fill; or require the Contractor to obtain material elsewhere. Material obtained elsewhere will be paid for in accordance with Section 1-04.4.

Controlled density fill shall meet the following requirements:

Controlled Density Fill

Ingredients	Amount per cubic meter
Portland Cement	30 kg
Fine Aggregate Class 1 or 2	1950 kg (2050 kg if Fly Ash Class C is used)
Air Entrainment Admixture	Per manufacturer's recommendations
Fly Ash Class F or	180 kg
Fly Ash Class C	90 kg
Water	180 kg (maximum)

The materials consistency shall be flowable (approximate slump 75 mm to 250 mm). If requested by the Contractor, the proportions may be adjusted with the approval of the Engineer.

The producer shall provide a Certificate of Compliance for each truckload of controlled density fill. The Certificate of Compliance shall verify that the delivered material is in compliance with the mix design and shall include:

Agency Contract No.
Date
Truck No.
Batched Masses of Each Ingredient

The certification shall be signed by a responsible representative of the producer, other than the driver, affirming the accuracy of the information provided.

Stockpiling. The Engineer may require the Contractor to selectively remove and stockpile any usable material excavated for a structure. If this material meets the requirements for gravel backfill for walls it may replace gravel as wall or abutment backfill.

If the Contractor stockpiles excavated material for use as backfill, it shall be protected with plastic sheeting or by some other method from contamination and weather damage. If the material becomes too wet or contaminated in the stockpile, the Contractor shall dispose of and replace it with an equal amount of suitable material, all at no expense to the Contracting Agency. All costs for storing, protecting, rehandling, and placing stockpiled material shall be included in the unit contract price for structure excavation, Class A or B.

Compaction. Backfill from structure excavation shall be placed and compacted in keeping with the following requirements:

1. Backfill supporting roadbed, roadway embankments, or structures — placed in horizontal layers no more than 150 millimeters thick with each layer compacted to 95 percent of the maximum density determined by the Compaction Control Test, Section 2-03.3(14)D.
2. Gravel backfill for drains — placed in horizontal layers no more than 0.3 meter thick, with each layer compacted by at least three passes of a vibratory compactor approved by the Engineer.
3. All other structure excavation backfill — placed in layers no more than 0.5 meter thick (loose), with each layer tamped and graded so that final settling will leave the backfill flush with surrounding ground.
4. Compaction of controlled density fill will not be required.

Timing. Backfill shall not be placed against any concrete structure until the concrete has attained 90 percent of its design strength and has cured for at least 14 days. However, the Contractor may backfill footings and columns as soon as forms have been removed, so long as the backfill is brought up evenly on all sides.

The Engineer may order the Contractor to use lean concrete in backfilling around piers and in front of abutments and walls. The Contracting Agency will pay for such backfilling as provided in Section 1-04.4.

If water prevents the Contractor from properly placing and compacting backfill, it shall be removed by pumping or other means.

All costs not defined in this section that relate to providing, placing, and compacting backfill shall be at the Contractor's expense.

2-09.3(1)F Items to Remain

If the Contractor damages or removes pavement or anything else meant to remain outside the excavation area, it shall be repaired or replaced at no expense to the Contracting Agency.

2-09.3(2) Classification of Structure Excavation

1. **Class A.** Structure excavation required for bridge footings, pile caps, seals, wing walls, and retaining walls shall be classed as structure excavation Class A. If the excavation requires a cofferdam and/or shoring or extra excavation, the work outside the neat lines of the structure excavation Class A shall be classed as shoring or extra excavation Class A.

2. **Class B.** All other structure excavation shall be Class B. If this excavation requires cofferdams, shoring, or extra excavation, the work outside the neat lines of the structure excavation Class B shall be classed as shoring or extra excavation Class B.

2-09.3(3) Construction Requirements, Structure Excavation, Class A

2-09.3(3)A Preservation of Channel

When foundations or substructures are to be built in or next to running streams, the Contractor shall:

1. Excavate inside cofferdams, caissons, or sheet piling unless dredging or open pit excavation is permitted.
2. Never disturb the natural stream bed next to the structure.
3. Backfill after foundations are placed inside cofferdams and any open pit or dredged area behind sheet piling. This backfill shall be level with the original stream bed and shall prevent scouring.
4. Remove any excavation material that may have been deposited in or near the stream so that the stream bed is free from obstruction.
5. Maintain water depth and horizontal clearances required for traffic to pass on navigable streams, furnishing any channel signals or lights required during construction.
6. Place riprap around the outside of cofferdams to repair local scour.

2-09.3(3)B Excavation Using Open Pits — Extra Excavation

The Contractor may dig open pits or perform extra excavation without shoring or cofferdams, if:

1. Footings can be placed in dry material away from running water.
2. The integrity of the completed structure and its surroundings is not reduced.
3. Worker safety is ensured as required by law.
4. The excavation does not disturb the existing pavement or any other adjacent facilities.

If a slide occurs in an open pit, the Contractor shall remove the slide material. If the slide disturbs an area over which a highway will be built, the Contractor shall backfill and compact the site to the original ground line as the Engineer directs. The Contractor shall pay all costs related to removing slide material and restoring a slide area.

The Contractor shall drain or pump any water from the pit, taking care not to stir up or soften the bottom. If equipment in the pit or inadequate water removal makes the foundation material unstable, the Contractor shall, at no expense to the Contracting Agency, remove and replace it with material the Engineer approves.

When the Engineer believes ground water flow may impair a concrete footing, the Contractor shall place under it a layer of gravel at least 150 millimeters thick. Before placing the gravel, the Contractor shall excavate to whatever grade the Engineer requires. This provision shall not apply to the building of concrete seals.

The Contractor may omit forms when the earthen sides of a footing excavation will stand vertically. In this case, the Contractor may excavate to the neat line dimensions of the footing and pour concrete against the undisturbed earth. If the hole is larger than neat line dimensions, the Contractor shall bear the cost of the extra concrete.

2-09.3(3)C Preparation for Placing Foundations

When a foundation will rest on rock, excavation shall penetrate it at least 0.3 meter, or more if the plans require, to form a key for the footing. The Contractor shall cut the bottom of the excavation to a firm surface, level, stepped, or serrated as the Engineer directs, and remove all loose material.

For an arch abutment, the back face shall be trimmed to true lines so that concrete can be poured against undisturbed material.

If concrete will rest on any excavated surface other than solid rock, the Contractor shall not disturb the bottom of the excavation. The Contractor shall also remove all loose or soft material just before pouring the concrete.

Upon completing any foundation excavation, the Contractor shall notify the Engineer. No concrete or other permanent part of the structure may be placed until the Engineer has given permission to proceed.

2-09.3(3)D Shoring and Cofferdams

The Contractor shall provide plans showing proposed methods and construction details of shoring or cofferdams in accordance with Sections 6-01.9 and 6-02.3(16). The Contractor shall not begin construction until approval has been given by the Project Engineer. When shoring or cofferdams are utilized, all excavation and shoring shall be constructed in accordance with the approved shoring plan, including any required construction sequence noted on the plan. The Contractor shall remain responsible for satisfactory results.

All excavations 1.22 meters or more in depth shall be shored or protected by cofferdams, or shall meet the open-pit requirements of Section 2-09.3(3)B.

The Contractor shall use cofferdams in all excavation that is under water or affected by ground water. A cofferdam is any watertight enclosure, sealed at the bottom, that surrounds the excavated area of a structure.

In using cofferdams or shoring, the Contractor shall:

1. Extend them well below the bottom of the excavation.
2. Provide enough clearance for building forms, inspecting concrete exteriors, and pumping water that collects outside the forms. If cofferdams tilt or move laterally during placement, the Contractor, at no expense to the Contracting Agency, shall straighten or enlarge them to provide the required clearance.
3. Secure the cofferdam in place to prevent tipping or movement.
4. Place shoring and cofferdams so that they will not interfere with any pile driving required.
5. Vent cofferdams at the elevation commensurate with seal weight design, or as shown in the Plans.
6. Remove any bracing that would extend into the concrete being placed.

When the work is completed, the Contractor shall:

1. Remove all shoring to at least 0.5 meter below finished ground line.
2. Remove all cofferdams to the natural bed of the waterway.

2-09.3(3)E Bearing Tests

The Engineer may stop the excavation to make bearing tests at any time. The Contractor shall assist with these tests in any way the Engineer requires.

During any test period, the Contractor shall, at no expense to the Contracting Agency, maintain ordinary working conditions at the bottom of the hole. The Contracting Agency will pay force account for all labor and materials the Contractor supplies for such tests. A single test shall not exceed 72 hours.

2-09.3(4) Construction Requirements, Structure Excavation, Class B

The above requirements for structure excavation Class A, shall apply also to structure excavation Class B. In addition, the Contractor shall follow Division 7 of these Specifications as it applies to the specific kinds of work.

The hole for any catch basin or manhole shall provide at least 0.3 meter of clearance between outside structural surfaces and the undisturbed earth bank.

If workers enter any trench or other excavation 1.22 meters or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored or other safety method constructed in conformance with WISHA requirements. The Contractor alone shall be responsible for worker safety and the Contracting Agency assumes no responsibility.

The Contractor must submit six sets of plans before shoring. These must meet the plan requirements set forth in Section 2-09.3(3)D.

Trench box approval can be done by the Project Engineer provided it is not used to support adjacent traffic, existing footings, or other structures. The Contractor shall submit three sets of the manufacturer's certified trench box plans containing Professional Engineer's stamp and seal, depth restrictions, and serial number for field verification of trench box.

Upon completing the work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

2-09.4 Measurement

Excavated materials will be measured in their original position by the cubic meter. The Contracting Agency will measure and pay for only the material excavated from inside the limits this section defines. If the Contractor excavates outside these limits or performs extra excavation as described in Section 2-09.3(3)B, it shall be considered for the Contractor's benefit and shall be included in the cost of other bid items.

Horizontal Limits. The Contracting Agency will use the sides of the trench or pit as horizontal limits in measuring excavation. No payment for structure excavation will be made for material removed (1) more than 0.3 meter outside the perimeter of any pile cap, footing, or seal, (2) more than 1 meter beyond the roadway side of a wing wall, and (3) more than 0.3 meter beyond the other sides and end of a wing wall.

For all pipes, pipe arches, structural plate pipes, and underpasses, the structure excavation quantity will be calculated based on the following trench widths:

For drain and underdrain pipes, trench width = I.D. + 300 mm.

For pipes 375 mm and under, trench width = I.D. + 750 mm.

For pipes 450 mm and over, trench width = (1.5 × I.D.) + 450 mm.

For a manhole, catch basin, grate inlet, or drop inlet, the limits will be 0.3 meter outside the perimeter of the structure.

For drywells, the limits shall be in accordance with the Standard Plans.

Lower Limits. For a pile cap, footing, or seal, the bottom elevation shown in the Plans, or set by the Engineer, will serve as the lower limit in measuring structure excavation. For a wing wall, the lower limit will follow a line parallel to the bottom and 0.3 meter below it. Any swell from pile-driving will be excluded from excavation quantities.

For pipelines the bottom outside of the pipe will serve as the lower limit for measuring excavation. The Engineer may set another limit when excavation must be made below grade.

Upper Limits. The top surface of the ground or stream bed as the work begins will be the upper limit for measuring excavation. If the Contract, or a separate contract, includes a pay item for grading to remove materials, the upper limit will be the neat lines of the grading section shown in the Plans.

The Engineer may order the Contractor to partially build the embankment before placing pipe. In this case, the upper limit for measurement will be not more than 1.2 meters above the invert of the pipe. For a structural plate pipe, pipe arch, or underpass, the upper limit will be the top of the embankment at the time of installation as specified in Section 7-03.3(1)A.

Gravel Backfill. Gravel backfill, except when used as bedding for culverts, storm sewer, sanitary sewer, manholes, and catch basins will be measured by the cubic meter in place determined by the neat lines required by the Plans.

Shoring or Extra Excavation. No specific unit of measurement shall apply to the lump sum item of shoring or extra excavation Class A. Shoring or extra excavation Class B will be measured by the square meter as follows:

The area for payment will be one vertical plane measured along the centerline of the trench, including structures. Measurement will be made from the existing ground line to the bottom of the excavation and for the length of the work actually performed. If the contract includes a pay item for grading to remove materials, the upper limit for measurement will be the neat lines of the grading section shown in the Plans. The bottom elevation for measurement will be the bottom of the excavation as shown in the Plans or as otherwise established by the Engineer.

Controlled density fill will be measured by the cubic meter for the quantity of material placed per the producer's invoice.

2-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Structure Excavation Class A", per cubic meter.

"Structure Excavation Class B", per cubic meter.

"Structure Excavation Class A Incl. Haul", per cubic meter.

"Structure Excavation Class B Incl. Haul", per cubic meter.

Payment for reconstruction of surfacing and paving within the limits of structure excavation will be at the applicable unit prices for the items involved.

If the Engineer orders the Contractor to excavate below the elevations shown in the plans, the unit contract price per cubic meter for "Structure Excavation Class A or B" will apply. But if the Contractor excavates deeper than the plans or the Engineer requires, the Contracting Agency will not pay for material removed from below the required elevations. In this case, the Contractor, at no expense to the Contracting Agency, shall replace such material with concrete or other material the Engineer approves.

"Shoring or Extra Excavation Cl. A _____", lump sum.

When extra excavation is used in lieu of constructing the shoring, cofferdam or caisson, the lump sum contract price shall be full pay for all excavation, backfill, compaction, and other work required. If select backfill material is required for backfilling within the limits of structure excavation, it shall also be required as backfill material for the extra excavation at the Contractor's expense.

If it is necessary to place riprap outside of cofferdams to repair local scour, it shall be paid by agreed price or force account.

If the Engineer requires shoring, cofferdams, or caissons when the contract provides no bid item for such work, the Contracting Agency will pay as provided in Section 1-04.4.

If the Engineer requires the Contractor to build shoring or extra excavation Class A that extends below the elevation shown in the Plans, the Contracting Agency will pay the lump sum price and no more when the extra depth does not exceed 1 meter. For depths greater than 1 meter below the elevations shown, payment will be as provided in Section 1-04.4.

"Shoring or Extra Excavation Class B", per square meter.

The unit contract price per square meter shall be full pay for all excavation, backfill, compaction, and other work required when extra excavation is used in lieu of constructing shoring. If select backfill material is required for backfilling within the limits of the structure excavation, it shall also be required as backfill material for the extra excavation at the Contractor's expense.

If there is no bid item for shoring or extra excavation Class B on a square meter basis and the nature of the excavation is such that shoring or extra excavation is required as determined by the Engineer, payment to the Contractor for the work will be made in accordance with Section 1-04.4.

"Gravel Backfill (Kind)", per cubic meter.

"Controlled Density Fill", per cubic meter.

2-10 DITCH EXCAVATION

2-10.1 Description

This work consists of excavating open ditches to the required lines, grades, and cross-sections. The work also includes disposing of all excavated material regardless of its nature or type.

Ditch Excavation: Includes all excavation in open ditches less than 2.5 meters wide at the bottom, but excludes ditches that are part of the roadway.

2-10.2 Vacant

2-10.3 Construction Requirements

Before excavating any open ditch, the Contractor shall clear and grub the area as required by Section 2-01.

The Contractor may build dikes or berms with excavated material, or may dispose of it as the Plans or the Engineer requires.

2-10.4 Measurement

Ditch excavation will be measured by the cubic meter in its original site, and the quantities calculated by the neat lines of the staked cross-sections.

2-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Ditch Excavation", per cubic meter.

For hauling, the Contracting Agency will pay the unit contract price for hauling excavated material (Section 2-04). If the pay item for excavation includes haul, the unit contract price per cubic meter shall cover all costs for hauling the material any distance required.

2-11 TRIMMING AND CLEANUP

2-11.1 Description

This work consists of dressing and trimming the entire roadway(s) improved under the contract, including frontage roads, connecting ramps, auxiliary lanes, and approach roads. This work extends to roadbeds, shoulders, and ditches.

2-11.2 Vacant

2-11.3 Construction Requirements

The Contractor shall:

1. Trim shoulders and ditches to produce smooth surfaces and uniform cross-sections that conform to the grades set by the Engineer.
2. Open and clean all channels, ditches, and gutters to ensure proper drainage.
3. Dress the back slope of any ditch or borrow pit that will remain adjacent to the roadway. Round off the top of the back slope and distribute the material evenly along its base.
4. Remove and dispose of all weeds, brush, refuse, and debris that lie on the roadbed, shoulders, ditches, and slopes.
5. Remove from paved shoulders all loose rocks and gravel.
6. Distribute evenly along the embankment any material not needed to bring the shoulders to the required cross-section.

The Contractor shall not:

1. Use heavy equipment (tractors, graders, etc.) to trim the shoulders of an existing or new bituminous surface.
2. Drag, push, or scrape shoulder material across completed surfacing or pavement.

When the contract requires the Contractor to rebuild part of a roadway only the rebuilt areas shall be trimmed and cleaned up. If the Contractor's work obstructs ditches or side roads, they shall be cleared and the debris disposed of as the Engineer directs.

2-11.4 Measurement

No specific unit of measurement shall apply to the lump sum item of trimming and cleanup.

2-11.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Trimming and Cleanup", lump sum.

2-12 CONSTRUCTION GEOTEXTILE

2-12.1 Description

The Contractor shall furnish and place construction geotextile in accordance with the details shown in the Plans.

2-12.2 Materials

Materials shall meet the requirements of the following section:

Construction Geotextile	9-33

Geotextile roll identification, storage, and handling shall be in conformance to ASTM D 4873. During periods of shipment and storage, the geotextile shall be stored off the ground. The geotextile shall be covered at all times during shipment and storage such that it is fully protected from ultraviolet radiation including sunlight, site construction damage, precipitation, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 70°C, and any other environmental condition that may damage the physical property values of the geotextile.

Unless specified otherwise in the Plans, the geotextile required for underground drainage shall be "Moderate Survivability" and "Drainage Class C" and permanent erosion control applications shall be "High Survivability" and "Drainage Class C."

2-12.3 Construction Requirements

The area to be covered by the geotextile shall be graded to a smooth, uniform condition free from ruts, potholes, and protruding objects such as rocks or sticks. The geotextile shall be spread immediately ahead of the covering operation. The geotextile shall not be left exposed to sunlight during installation for a total of more than 14 calendar days. The geotextile shall be laid smooth without excessive wrinkles. Under no circumstances shall the geotextile be dragged through mud or over sharp objects which could damage the geotextile. The cover material shall be placed on the geotextile such that the minimum initial lift thickness required will be between the equipment tires or tracks and the geotextile at all times. Construction vehicles shall be limited in size and weight, to reduce rutting in the initial lift above the geotextile, to not greater than 75 millimeters deep to prevent overstressing the geotextile. Turning of vehicles on the first lift above the geotextile will not be permitted.

Soil piles or the manufacturer's recommended method, shall be used as needed to hold the geotextile in place until the specified cover material is placed.

Should the geotextile be torn, punctured, or the overlaps or sewn joints disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or roadbed distortion, the backfill around the damaged or displaced area shall be removed and the damaged area repaired or replaced by the Contractor at no expense to the Contracting Agency. The repair shall consist of a patch of the same type of geotextile placed over the damaged area. The patch shall overlap the existing geotextile from the edge of any part of the damaged area by the minimum required overlap for the application.

If geotextile seams are to be sewn in the field or at the factory, the seams shall consist of one row of stitching unless the geotextile where the seam is to be sewn does not have a selvage edge. If a selvage edge is not present, the seams shall consist of two parallel rows of stitching, or shall consist of a J-seam, Type SSn-1, using a single row of stitching. The two rows of stitching shall be 25 millimeters apart with a tolerance of plus or minus 13 millimeters and shall not cross except for restitching. The stitching shall be a lock-type

stitch. The minimum seam allowance, i.e., the minimum distance from the geotextile edge to the stitch line nearest to that edge, shall be 40 millimeters if a flat or prayer seam, Type SSa-2, is used. The minimum seam allowance for all other seam types shall be 25 millimeters. The seam, stitch type, and the equipment used to perform the stitching shall be as recommended by the manufacturer of the geotextile and as approved by the Engineer.

The seams shall be sewn in such a manner that the seam can be inspected readily by the Engineer or a representative. The seam strength will be tested and shall meet the requirements stated herein.

2-12.3(1) Underground Drainage

Trench walls shall be smooth and stable. The geotextile shall be placed in a manner which will ensure intimate contact between the soil and the geotextile (i.e., no voids, folds, or wrinkles).

The geotextile shall either be overlapped a minimum of 300 millimeters at all longitudinal and transverse joints, or the geotextile joints shall be sewn for medium survivability drainage applications. In those cases where the trench width is less than 300 millimeters, the minimum overlap shall be the trench width.

In moderate survivability geotextile underdrain applications, the minimum overlap shall be 300 millimeters, or the geotextile joints shall be sewn, except where the geotextile is used in area drains. An area drain is defined as a geotextile layer placed over or under a horizontal to moderately sloping layer of drainage aggregate. For area drains, the geotextile shall be overlapped a minimum of 600 millimeters at all longitudinal and transverse joints, or the geotextile joints shall be sewn together. The minimum initial lift thickness over the geotextile in the area drain shall be 300 millimeters.

In all cases, the upstream geotextile sheet shall overlap the next downstream sheet.

2-12.3(2) Separation

The geotextile shall either be overlapped a minimum of 600 millimeters at all longitudinal and transverse joints, or the geotextile joints shall be sewn together. The initial lift thickness shall be 150 millimeters or more.

2-12.3(3) Soil Stabilization

The geotextile shall either be overlapped a minimum, of 600 millimeters at all longitudinal and transverse joints, or the geotextile shall be sewn together. The initial lift thickness shall be 300 millimeters or more. Compaction of the first lift above the geotextile shall be by Method A (Section 2-03.3(14)C). No vibratory compaction will be allowed on the first lift.

2-12.3(4) Permanent Erosion Control and Ditch Lining

Unless otherwise specified in the Plans, the geotextile shall either be overlapped a minimum of 600 millimeters at all longitudinal and transverse joints, or the geotextile joints shall be sewn together. If overlapped, the geotextile shall be placed so that the upstream strip of geotextile will overlap the next downstream strip. When placed on slopes, each strip shall overlap the next downhill strip.

Placement of aggregate and riprap or other cover material on the geotextile shall start at the toe of the slope and proceed upwards. The geotextile shall be keyed at the top and the toe of the slope as shown in the Plans. The geotextile shall be secured to the slope, but shall be secured loosely enough so that the geotextile will not tear when the riprap or other cover material is placed on the geotextile. The geotextile shall not be keyed at the top of the slope until the riprap or other cover material is in place to the top of the slope.

All voids in the riprap or other cover material that allow the geotextile to be visible shall be backfilled with quarry spalls or other small stones, as designated by the Engineer, so that the geotextile is completely covered. When an aggregate cushion between the geotextile and the riprap or other cover material is required, it shall have a minimum thickness of 300 millimeters.

An aggregate cushion will be required to facilitate drainage when hand placed riprap, sack riprap, or concrete slab riprap, as specified in Sections 9-13.2, 9-13.3, or 9-13.4, respectively, is used with the geotextile.

Grading of slopes after placement of the riprap or other cover material will not be allowed if grading results in stone movement directly on the geotextile. Under no circumstances shall stones with a mass of more than 45 kilograms be allowed to roll downslope. Stones shall not be dropped from a height greater than 1 meter above the geotextile surface if an aggregate cushion is present, or 0.3 meter if a cushion is not present. Lower drop heights may be required if geotextile damage from the stones is evident, as determined by the Engineer. If the geotextile is placed on slopes steeper than 1:2, the stones shall be placed on the slope without free-fall for moderate survivability, high survivability, and ditch lining geotextiles.

2-12.3(5) Temporary Silt Fences

The contractor shall install and maintain temporary silt fences at the locations shown in the Plans. The silt fences shall be constructed in the areas of clearing, grading, or drainage prior to starting those activities. A silt fence shall not be considered temporary if the silt fence must function beyond the life of the contract. The silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence. The minimum height of the top of silt fence shall be 750 millimeters and the maximum height shall be 1.0 meter above the original ground surface. Damaged or otherwise improperly functioning portions of silt fences shall be repaired or replaced by the Contractor at no cost to the Contracting Agency, as determined by the Engineer.The silt fence shall be maintained until vegetation has been established.

The geotextile shall be attached on the up-slope side of the posts and support system with staples, wire, or in accordance with the manufacturer's recommendations. The geotextile shall be attached to the posts in a manner which reduces the potential for geotextile tearing at the staples, wire, or other connection device. Silt fence back-up support for the geotextile in the form of a wire or plastic mesh is optional, depending on the properties of the geotextile selected for use in Table 6 in Section 9-33.2. If wire or plastic back-up mesh is used, the mesh shall be fastened securely to the up-slope of the posts with the geotextile being up-slope of the mesh back-up support.

The geotextile shall be sewn together at the point of manufacture, or at an approved location as determined by the Engineer, to form geotextile lengths as required. All sewn seams shall be located at a support post. Alternatively, two sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.

The geotextile at the bottom of the fence shall be buried in a trench to a minimum depth of 150 millimeters below the ground surface. The trench shall be backfilled and the soil tamped in place over the buried portion of the geotextile as shown in the Plans, such that no flow can pass beneath the fence nor scour occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the trench a minimum of 75 millimeters. The fence posts shall be placed or driven a minimum of 500 millimeters

into the ground. Fence post depths shall be increased by 150 millimeters if the fence is located on slopes of 1:3 or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading, as approved by the Engineer.

Silt fences shall be located on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence as shown in the Plans. If the fence must cross contours, with the exception of the ends of the fence, gravel check dams placed perpendicular to the back of the fence shall be used to minimize concentrated flow and erosion along the back of the fence. The gravel check dams shall be approximately 0.3 meter deep at the back of the fence and be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence as shown in the Plans. The gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. The gravel check dams shall be located every 3 meters along the fence where the fence must cross contours. The slope of the fence line where contours must be crossed shall not be steeper than 1:3.

Either wood or steel posts shall be used. Hardwood posts shall have minimum dimensions of 30 millimeters by 30 millimeters by the minimum length shown in the Plans, and shall be free of defects such as knots, splits, or gouges. If fir or hemlock is used (stud grade), the posts shall have minimum dimensions of 40 millimeters by 75 millimeters. Steel posts shall consist of either: ASTM A 53 steel pipe with a minimum diameter of 25 millimeters; U, T, L, or C shape steel posts with a minimum mass of 2 kg/m or other steel posts having equivalent strength and bending resistance to the post sizes listed. The spacing of the support posts shall be a maximum of 1.8 meters as shown in the Plans.

Fence back-up support, if used, shall consist of steel wire with a maximum mesh spacing of 50 millimeters, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than that required in Table 6 for unsupported geotextile (i.e., 800 N grab tensile strength). The polymeric mesh must be as resistant to ultraviolet radiation as the geotextile it supports.

Sediment deposits shall either be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed, as determined by the Engineer.

2-12.4 Measurement

Construction geotextile, with the exception of temporary silt fence geotextile and underground drainage geotextile used in trench drains, will be measured by the square meter for the ground surface area actually covered.

Temporary silt fence geotextile will be measured by the meter of completed fence along the ground line.

Underground drainage geotextile used in trench drains will be measured by the square meter for the perimeter of drain actually covered.

2-12.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Construction Geotextile for Underground Drainage," per square meter.

"Construction Geotextile for Separation," per square meter.

"Construction Geotextile for Soil Stabilization," per square meter.

"Construction Geotextile for Permanent Erosion Control," per square meter.

"Construction Geotextile for Ditch Lining," per square meter.

"Construction Geotextile for Temporary Silt Fence," per meter.

Sediment removal behind silt fences will be paid by force account under temporary water pollution/erosion control. If a new silt fence is installed in lieu of sediment removal, the silt fence will be paid for at the unit contract price per meter for "Construction Geotextile for Temporary Silt Fence."

DIVISION 3
PRODUCTION FROM QUARRY AND PIT SITES AND STOCKPILING

3-01 PRODUCTION FROM QUARRY AND PIT SITES

3-01.1 Description

This work shall consist of manufacturing and producing crushed and screened aggregates including pit run aggregates of the kind, quality, and grading specified for use in the construction of Portland cement concrete, asphalt concrete, asphalt treated base, crushed surfacing, maintenance rock, ballast, gravel base, gravel backfill, gravel borrow, riprap, and bituminous surface treatments of all descriptions.

The requirements specified shall apply whether the source is ledge rock, talus, gravel, sand, or any combination thereof.

3-01.2 Material Sources, General Requirements

3-01.2(1) Approval of Source

Material sources must be approved in advance of use in the work in accordance with the requirements of Section 1-06. This approval of source may require sampling and testing. If sampling is required, the samples must be taken at locations designated and witnessed by the Engineer or a designated representative. The Contractor is responsible for providing representative preliminary samples of aggregate sources to the Engineer.

3-01.2(2) Preparation of Site

The portion of the quarry or pit site to be used shall be cleared and grubbed, and the area from which materials are to be taken shall be stripped of overburden as provided in Section 3-01.2(3). All combustible debris resulting from these operations shall be disposed of by the Contractor in a manner satisfactory to the Engineer.

3-01.2(3) Stripping Quarries and Pits

Stripping of quarries and pits shall consist of the removal, after clearing and grubbing, of the surface material and overburden which is unsuitable for the kind of material to be borrowed or produced for use. Materials from stripping, to be used later as provided on the site reclamation plan specified in Section 3-03, shall be deposited within the quarry or pit site at such a location as not to interfere with future development within the site.

3-01.2(4) Production Requirements

All oversize stones, rock fragments, or boulders occurring in the source, up to and including those measuring 0.5 meter in the greatest dimension, shall be utilized in the manufacture of crushed material.

If the grading or quality of raw material in sources used for the manufacture of products covered by this section is such that the fracture, grading, or quality of the product specified cannot be obtained by utilizing the natural material, fine portions of the raw material shall be rejected to the extent necessary to produce products meeting all requirements of these Specifications. Failure of the Contracting Agency to include a scalping requirement in the special provisions shall not relieve the Contractor of the responsibility

for rejecting fine portions of the material if such becomes necessary to produce products meeting all requirements of these Specifications. Scalping shall be performed after the pit-run or quarry-run material has passed through the primary crusher.

When scalping over a screen of a specified size is required in the special provisions, the scalping screen shall be of such size and capacity that enough of the fine material will be removed to produce specification material.

Washing and reclaiming of the reject material and subsequent addition of this material to any finished products will not be allowed unless specifically authorized in writing by the Engineer.

Surplus screenings accumulated during the crushing and screening of specified roadway materials will be considered separate and distinct from reject material resulting from scalping operations.

Both fine and coarse concrete aggregates shall be thoroughly washed in order to remove clay, loam, alkali, bark, sticks, organic castings, or other deleterious matter. Washing will be required in the production of other materials if necessary to produce products meeting all the quality requirements of these Specifications.

When producing screened gravel or sand materials, the Contractor shall remove all oversize material by screening at the pit site. The Contractor's operations in the pit shall be conducted so that the grading of individual loads will be reasonably uniform. In general, the Contractor shall utilize the most suitable materials available and shall make as many moves of the loading equipment as may be necessary to fulfill these requirements.

Where pit-run materials meet specifications, screening or processing will not be required.

3-01.2(5) Final Cleanup

Upon completion of the Contractor's operation, the quarry or pit shall be cleared of all rubbish, temporary structures, and equipment, and shall be left in a neat and presentable condition. The pit or quarry shall be reclaimed in accordance with the approved site reclamation plan specified in Section 3-03.

3-01.3 State Furnished Material Sources

Unless specified in the Special Provisions, no Contracting Agency material sources are provided and the contractor shall bear full responsibility for furnishing all materials.

3-01.3(1) Quality and Extent of Material

Contracting Agency furnished material sources will be shown in the Plans and described in the Special Provisions. The quality of material in such sources will be acceptable in general, but the Contractor shall determine the amount of equipment and work required to produce the material meeting these Specifications. It shall be understood that it is not feasible to ascertain from samples, the limits for an entire source, and that variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a source and may reject portions of the source as unacceptable.

Since many material sources are acquired in fee by the Contracting Agency for use on future projects as well as for this contract, it is in the public interest to preserve the future usefulness and adequacy of a source insofar as may be practical. To achieve this end, the Contractor shall not perform any work within the source until receiving the Engineer's approval of the Contractor's work plan within the limits of the source.

3-01.3(2) When More Than One Site Is Provided

When more than one quarry or pit site is provided in the Special Provisions, the Contractor may obtain material from any of the sources. The Contracting Agency will specify the quantity of raw material available, as determined by tests, in each quarry or pit site. If the Contractor sets up in a site, and it is found that the quantity of raw material from that site, when the site is exhausted, is less than that specified by the Contracting Agency, then the provisions of Section 3-01.3(5) will apply.

3-01.3(3) Reject Materials

All scalpings that are unsatisfactory for use under these Specifications or Special Provisions shall be considered as reject material, subject to disposal as approved by the Engineer. Reject material shall be placed at such a location as not to interfere with future development within the site.

3-01.3(4) Surplus Screenings

The surplus screenings accumulated during the production of the specified materials shall be stockpiled at a location within the site provided and become the property of the Contracting Agency. The stockpile site shall be prepared and constructed by the Contractor in accordance with the provisions of Section 3-02. All costs incurred in producing, hauling, and stockpiling the surplus screenings shall be incidental to the production of the specified materials and shall be included by the Contractor in the unit bid prices in the contract.

3-01.3(5) Moving Plant

If, in the opinion of the Engineer, there should be insufficient suitable material in any quarry or pit site made available by the Contracting Agency, the Contracting Agency will acquire at its expense an additional source, in which event the Contractor will be required to move the crushing plant to the new quarry or site. Under such conditions, payment for the Contractor's costs for the move will be made on a force account basis. Payment will be limited to the labor, equipment, and materials required for the move, and no allowance will be made for payment of standby costs for the crushing plant nor other equipment which may be temporarily idle as a result of the move.

The clearing, grubbing, and preparing of the new quarries or pit sites as specified in Section 3-01.2(2) will be paid for in the manner provided in these specifications for "Clearing", "Grubbing", and "Stripping Including Haul". If there is no bid item applicable, the payment for the preparation of the new site will be as provided in Section 1-04.4.

If the moving of the plant due to shortage of the supply of material necessitates a longer haul on materials than required from the original source, the Contracting Agency will reimburse the Contractor for the additional haul at the rate of $0.15 per tonne kilometer haul. The unit tonne kilometer shall be the equivalent of one tonne of material hauled a distance of 1 kilometer. The haul distance will be measured in one-half kilometer units, fractional half-kilometers being allowed as full half-kilometers. If the requirement for moving of the crushing plant results in a delay of performance of work which is critical to completion of the project, as shown by the Contractor's approved progress schedule, the Engineer will authorize a suspension of work for the time required for the move.

The above allowances, insofar as they may be applicable, shall be full pay for all claims of any kind or description by reason of the necessity of changing from one site to another due to shortage of the supply from sources made available by the Contracting Agency. Before moving a crushing plant as outlined above, the Contractor shall secure from

the Engineer an order in writing to do so. Should the Contractor fail to secure such order, it shall be considered sufficient proof that the move was immaterial insofar as to cost, and no allowance or pay will be made by reason of such move.

3-01.4 Contractor Furnished Material Sources

3-01.4(1) Acquisition and Development

If, under the terms of the Contract, the Contractor is required to provide a source of materials, or if the Contractor elects to use materials from sources other than those provided by the Contracting Agency, the Contractor shall, at no expense to the Contracting Agency, make all necessary arrangements for obtaining the material and shall ensure the quantity of suitable material is available. The Contractor is responsible for providing representative preliminary samples to the Engineer. All preliminary sampling is to be witnessed by the Engineer or a designated representative. Approval of the source does not relieve the Contractor from meeting the Acceptance Requirements of the material, nor does it guarantee that the material will meet those requirements without additional or proper processing.

Approval of a Contractor's source offered in lieu of a Contracting Agency-provided source will be contingent upon the material therein being of equal quality, and no additional costs will accrue to the Contracting Agency as a result of such approval. Equivalency of quality will be based on those test values listed in the special provisions as being representative of material in the Contracting Agency-provided source. If no such values are listed, the minimum specification requirements will apply. When measurement by mass is specified and when the specific gravity of material produced from the Contractor's source is greater than that from the Contracting Agency-furnished source, any additional material required to construct the minimum specified surfacing depth shall be furnished by the Contractor at no expense to the Contracting Agency.

The Contractor shall notify the State Departments of Ecology, Fish and Wildlife, and Natural Resources, in writing, of the intent to furnish the source, and shall, at no expense to the Contracting Agency, make all necessary arrangements with these agencies for the determinations of regulations which might be imposed upon the Contractor during removal of materials from the source.

The source shall be selected so that, after the materials have been removed, the pit will drain to a natural drainage course and no ponding will result. Should the source selected by the Contractor be one which would not drain as outlined herein, permission shall be obtained by the Contractor from the governing body of the city or county for the removal of materials from the pit or quarry.

The Contractor will not be permitted to operate a pit or a quarry site visible from a state highway unless it can be demonstrated to the complete satisfaction of the Engineer that no unsightly condition will result from or remain as a result of the Contractor's operations. If, in the opinion of the Engineer, unsightly conditions exist after removal of materials from the site, the Contractor shall correct such unsightly conditions as hereinafter provided.

Following removal of materials from the pit, the entire site shall be cleared of all rubbish, temporary structures, and equipment which have resulted from the Contractor's occupancy and operations. The Contractor shall obliterate or screen to the satisfaction of the Engineer any unsightly conditions that remain. The Contractor shall secure a written release from the permitter upon fulfillment of these requirements. All costs for cleaning up

the pit site and for the installation or erection of screening or for other work required to correct unsightly conditions shall be at the Contractor's expense. The requirements of this paragraph shall not apply to pits being operated commercially.

All costs in connection with acquiring the rights to take materials from the source, for exploring and developing the site, for complying with the regulations of the aforesaid State agencies, for preparing the site as provided in Sections 3-01.2(2) and 3-03, for cleaning up the site, and for correcting unsightly conditions, shall be included in the unit contract prices for the various pay items of work involved.

3-01.4(2) Surplus Screenings

Surplus screenings accumulated during the manufacture of specified material shall remain the property of the Contractor.

3-01.4(3) Substitution of Gravel Deposit in Lieu of Ledge Rock or Talus Source Provided by the Contracting Agency

If the Contractor elects to substitute a gravel deposit of an approved source for the manufacture of ballast, crushed surfacing, or mineral aggregate in lieu of a ledge rock or talus source provided by the Contracting Agency in the contract, all pit run materials passing a 12.5 millimeter square sieve, or larger if ordered by the Engineer, shall be removed prior to crushing.

3-01.4(4) Gravel Base

If the contract requires the Contractor to provide the source of Gravel Base, or if the Contractor elects to furnish said material from sources other than those provided by the Contracting Agency, the material shall be produced from approved sources in accordance with the requirements of Section 3-01. The grading and quality shall be as specified in Section 9-03.10.

When Gravel Base is specified, Gravel Borrow may be used in lieu of Gravel Base provided the stabilometer value of the Gravel Borrow is a minimum of 67 and 30 millimeters of crushed surfacing top course is substituted for the top 30 millimeters of the depth specified for Gravel Base.

Measurement and payment will be in accordance with Section 4-02.

3-01.5 Measurement

For payment purposes, all crushed, screened, or naturally occurring materials that are to be paid for by the tonne, dependent upon their grading, will be limited to the following water contents naturally occurring in the material source:

% By Mass Passing 6.3 Millimeter Sieve	Maximum Water Content % By Mass
Less than 20%	4%
20% or more	8%

Water in excess of the maximum permissible amounts naturally occurring in the material source, as determined by the Engineer, will be deducted from the tonneage of material to be paid for on a daily basis.

If the Contractor uses the Central Plant Mix Method of mixing water and surfacing materials in accordance with Section 4-04, the added water will be measured in accordance with Section 4-04.4. All other water added to the materials by the Contractor will be deducted from the mass of the aggregates including the added water, on a daily basis.

Clearing and grubbing of quarries and pit sites will be measured in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

Stripping of quarries and pit sites will be measured in cubic meters in its original position by cross-sectioning when the proposal includes such bid item and such stripping is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

Measurement of the particular materials or aggregates to be produced will be as specified in the appropriate section of these Specifications.

3-01.6 Payment

All costs, except as specified, in connection with the production of materials meeting all quality requirements of these Specifications shall be included in the unit contract prices of the various bid items involved.

Clearing and grubbing of quarries and pit sites will be paid in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

"Stripping Incl. Haul" will be paid for at the unit contract price per cubic meter when the proposal includes such bid item and such stripping is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

3-02 STOCKPILING AGGREGATES

3-02.1 Description

This work shall consist of preparing the stockpile sites and placing the specified aggregates in the stockpiles at the sites and in the amounts as shown in the Plans or as approved by the Engineer.

This section also includes the requirements pertaining to the removal of aggregates from stockpiles and the requirements for dressing up the stockpiles and stockpile site at the completion of the work.

3-02.2 General Requirements

3-02.2(1) Stockpile Sites Provided by the Contracting Agency

The Contracting Agency may acquire and make available to the Contractor suitable areas as shown in the Plans for the construction of stockpiles. The stockpiled aggregates may be for use in the immediate work or may be for future use as more fully described below. In either event, if the aggregates are required by these Specifications to be stockpiled, all costs in connection with the preparation of the stockpile sites as required in Section 3-02.2(5) shall be included in the various bid items involved in the contract; except that clearing and grubbing of the site will be measured and paid for in accordance with Section 2-01 only when such bid items are included in the proposal. In the event there is no bid item included in the proposal for construction and maintenance of haul roads to the stockpile site, the Contractor shall construct and maintain the haul roads as necessary and the cost thereof shall be included in the various bid items in the contract.

3-02.2(2) Stockpile Site Provided by the Contractor

If the Plans do not provide a stockpile site for the use of the Contractor in stockpiling certain types and sizes of aggregates which are required by these Specifications to be stockpiled prior to use in the immediate work, all costs in connection with the acquisition of a site, the preparation of the site, construction of the stockpiles, and the removal of the aggregates from the stockpiles shall be included in the contract prices of the various bid items of work involved.

3-02.2(3) Stockpiling Aggregates for Future Use

The Contracting Agency may require the production and stockpiling of aggregates on sites provided by the Contracting Agency for use on future construction or maintenance projects to be performed under a subsequent contract or by Contracting Agency forces.

When the contract includes the bid item or items for specific aggregates in stockpile and these aggregates are not to be used in work required under the contract, the Contractor shall produce or furnish these aggregates complying with the quality and grading requirements of these Specifications and shall prepare the site and place the aggregates in stockpile in accordance with the requirements of this Section or as directed by the Engineer.

3-02.2(4) Stockpiling Aggregates for Immediate Use

If the Contractor elects to stockpile aggregates from a source owned or controlled by the Contracting Agency prior to use in the immediate work, the stockpiling shall be done within the area of the site provided by the Contracting Agency and in accordance with the requirements of these Specifications. If the Contractor elects to lease land to stockpile the

aggregates, the stockpiling shall be done in accordance with these Specifications and upon proof that the lease will extend for a period of not less than one year beyond the completion date of the contract. All excess aggregates remaining in stockpiles after satisfying the needs of the contract — whether upon the site provided by the Contracting Agency or upon land leased by the Contractor — shall be disposed of in accordance with Section 1-09.10. All costs resulting from the production of the excess aggregates shall be included in the cost of production of the aggregates actually incorporated in the work.

If the Contractor elects to stockpile aggregates from a source not provided by the Contracting Agency prior to use in the immediate work, it will be subject to the approval of the Engineer and provided that the aggregates comply with the quality and grading requirements of these Specifications. All costs in connection with the acquisition of the stockpile site, the preparation of the site, construction of the stockpiles, and the removal of the aggregates from the stockpiles shall be included in the contract prices of the various bid items of work involved.

3-02.2(5) Preparation of Site

Before placing aggregates upon the stockpile site, the site shall be cleared of vegetation, trees, stumps, brush, rocks, or other debris and the ground leveled to a smooth, firm, uniform surface. The debris resulting from clearing and preparing the site shall be disposed of in a manner satisfactory to the Engineer.

3-02.2(6) Construction of Stockpiles

Stockpiles shall be constructed upon the prepared sites in accordance with stakes set by the Engineer. The piles when completed shall be neat and regular in shape. The stockpile height shall be limited to a maximum of 7.5 meters.

Stockpiles in excess of 200 cubic meters shall be built up in layers not more than 1.2 meters in depth. Stockpile layers shall be constructed by trucks, clamshells, or other methods approved by the Engineer. Pushing aggregates into piles with a bulldozer will not be permitted. Each layer shall be completed over the entire area of the pile before depositing aggregates in the succeeding layer. The aggregate shall not be dumped so that any part of it runs down and over the lower layers in the stockpile. The method of dropping from a bucket or spout in one location to form a cone shaped pile will not be permitted. Any method of placing aggregates in stockpiles, which in the opinion of the Engineer, breaks, degrades, or otherwise damages the aggregate, will not be permitted. Plank runways will be required, when deemed necessary by the Engineer, for operating trucks on stockpiles to avoid tracking dirt or other foreign matter onto the stockpiled materials. Stockpiles of less than 200 cubic meters shall be piled in a manner to prevent segregation of the various sizes of material.

No equipment other than pneumatic tired equipment shall be used in constructing the stockpiles of processed or manufactured aggregates.

Stockpiles of different types or sizes of aggregate shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates. Aggregate shall not be deposited where traffic, vehicles, or Contractor's equipment will either run over or through the piles, or in any way cause foreign matter to become mixed with the aggregates.

3-02.2(7) Removing Aggregates from Stockpiles

Aggregates shall be removed from stockpile in a manner to avoid separation of sizes or admixture of dirt or foreign material. The method and equipment used for loading will be approved by the Engineer.

No equipment other than pneumatic tired equipment shall be used on stockpiles of processed or manufactured aggregates in removing the materials from the stockpiles. When removing materials from the face of the stockpile, the equipment shall be operated in a manner to face-load from the floor to the top of the stockpile to obtain maximum uniformity of material.

The Contractor shall remove only the amount of materials from the stockpile required to satisfy the needs of the contract. If a surplus remains in the stockpile, the Contractor shall leave the surplus material in neat, compact piles, free of foreign matter. The entire stockpile site shall be left in a neat and presentable condition.

3-02.3 Additional Requirements for Specific Aggregates

3-02.3(1) Asphalt Concrete Aggregates

Aggregates for Classes A, B, and E shall be produced or furnished in the following sizes as they apply to the class of asphalt concrete to be produced: 31.5 millimeter-6.3 millimeter, 16 millimeter-6.3 millimeter, and 6.3 millimeter-0. Each size shall be stockpiled separately regardless of whether it is being produced for future work or for immediate use, except as modified in Section 9-03.8.

Aggregates for Classes D and G shall be produced or furnished and stockpiled in the one size as specified in Section 9-03.8.

Aggregates for Class F shall be produced or furnished in sizes designated 19 millimeter-6.3 millimeter and 6.3 millimeter-0 if for use on future work and shall be stockpiled separately. If for use in the immediate work, separation into the two sizes will not be required.

3-02.3(2) Washed Aggregates

Drain pipes under the stockpile shall be provided at the Contractor's expense when, in the opinion of the Engineer, such drains are necessary to properly drain the aggregates.

The roads and ground adjacent to the stockpile shall be kept free of dust. Washed aggregate that has become coated with foreign material prior to use shall be washed until free of all foreign material or it may be rejected.

Washed aggregate shall drain in hauling conveyances or stockpiles at least 12 hours before being weighed or measured for batching and for a longer time if so directed by the Engineer.

3-02.4 Measurement

Clearing and grubbing of the stockpile site will be measured in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a stockpile site provided by the Contracting Agency.

Specific materials or aggregates designated in the proposal to be in stockpile will be measured by the tonne unless the proposal shows by the cubic meter. The cubic meter volume for pay quantity will be determined by cross-sectioning the completed stockpile or by computation of the volume between the original ground surface and the stockpile surface using digital terrain modeling survey techniques.

Specific materials or aggregates designated in the proposal to be from stockpile will be measured by the tonne or by the cubic meter, whichever is shown in the proposal. If payment is to be made on the basis of cubic meters, measurement will be made of the volume in the hauling vehicle at the point of delivery on the roadway.

3-02.5 Payment

All costs involved in preparing stockpile sites shall be included in the unit contract prices for the various bid items being stockpiled, excepting that clearing and grubbing will be paid in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a stockpile site provided by the Contracting Agency.

3-03 SITE RECLAMATION

3-03.1 Description

This work shall consist of reclaiming land used for borrowing material, mining for aggregates, sorting or wasting materials as specified.

3-03.2 General Requirements

3-03.2(1) Contracting Agency-Provided Sites

All borrow, quarry, or pit sites of over 1.2 hectares in size of disturbed land or resulting in pit walls more than 9.15 meters high and steeper than a one to one slope which are owned or furnished by the Contracting Agency shall be reclaimed as shown in the Plans and as designated by the Engineer.

Ultimate reclamation plans are not normally required for borrow, quarry, or pit sites not meeting the above criteria or for stockpile or waste sites. However, all such sites shall be reclaimed to the extent necessary to control erosion and provide a satisfactory appearance consistent with anticipated future use.

3-03.2(2) Contractor-Provided Sites

All borrow, quarry, and pit sites of over 1.2 hectares in size of disturbed land or resulting in pit walls more than 9.15 meters high and steeper than a one to one slope which are owned or furnished by the Contractor shall be reclaimed in accordance with the conditions and requirements of an approved reclamation permit acquired from the Department of Natural Resources.

When the Contractor obtains a reclamation permit from the Department of Natural Resources, evidence of such approval shall be furnished to the Engineer prior to any work within the site.

Ultimate reclamation plans are not required for borrow, quarry, or pit sites not meeting the above criteria or for stockpile or waste sites. However, all such sites shall be reclaimed to the extent necessary to control erosion and provide a satisfactory appearance consistent with anticipated future use.

Compliance with the State Environmental Policy Act (SEPA) is required for sites involving more than 76 cubic meters of excavation or landfill throughout the lifetime of the site unless the local agency in which the project is located establishes a greater amount. Sites involving more than 382 cubic meters of excavation or landfill throughout the lifetime of the site always require compliance with SEPA.

Under no circumstance will the Contractor be allowed to waste material within a wetland as defined in Section 2-03.3(7).

3-03.2(3) Out of State Sites

All out of state borrow, quarry or pit, stockpile, and waste sites which are furnished by the Contractor exclusively for use on this contract shall be reclaimed in accordance with an approved reclamation plan that is in compliance with local area restrictions.

3-03.3 Reclamation Plans

3-03.3(1) Contracting Agency-Provided Sites

Reclamation plans for all borrow, quarry, or pit sites which are owned or furnished by the Contracting Agency will normally be furnished by the Contracting Agency and the requirements thereof included in the contract documents. Should conditions require

operations within a Contracting Agency-owned or Contracting Agency-furnished site not provided for in the plans, the Contractor shall reclaim these sites in accordance with a reclamation plan furnished by the Engineer.

3-03.3(2) Contractor-Provided Sites

A plan will not be required except on specific request for those sources of material for which the Contractor has obtained a valid surface mining permit issued by the Department of Natural Resources and has paid all required fees.

3-03.4 Construction Requirements

3-03.4(1) Erosion Control

All sites owned or furnished by the Contracting Agency will specify the kind and amount of erosion control, if any, and include the requirements thereof in the contract documents.

All sites owned or furnished by the Contractor shall, if specified on a reclamation plan approved by the Engineer, require erosion control in accordance with Section 8-01 or plant materials in accordance with Section 8-02.

3-03.4(2) Deviations from Approved Reclamation Plans

Reclamation of any site which deviates from the approved reclamation plan will not be permitted without first revising the approved reclamation plan and obtaining the approval of the Engineer.

3-03.5 Payment

3-03.5(1) Contracting Agency-Provided Sites

All costs in connection with reclaiming sites to the full extent required by the contract shall be included in the costs of other items of work involved in the project.

Payment will be made for any work described in Sections 8-01 or 8-02 at applicable unit contract prices.

3-03.5(2) Contractor-Provided Sites

All costs involved in complying with the requirements of a reclamation permit acquired from the Department of Natural Resources, complying with the requirements of a reclamation plan approved by the Engineer, or with reclaiming sites to the full extent required by the contract shall be included in the costs of other items of work involved in the project.

DIVISION 4
BASES

4-02 GRAVEL BASE

4-02.1 Description

This work shall consist of constructing one or more layers of gravel base upon a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Plans or as established by the Engineer.

4-02.2 Materials

Materials shall meet the requirements of the following section:

Gravel Base	9-03.10

4-02.3 Construction Requirements

Gravel base shall be uniformly spread upon the prepared subgrade to the depth, width, and cross-section shown in the Plans. Construction methods used shall meet the applicable requirements of Sections 4-04.3.

4-02.4 Measurement

Gravel base will be measured in the same manner prescribed for the measurement of crushed surfacing materials as set forth in Section 4-04.4 except as follows:

Where gravel base is specified, the Contractor may elect to substitute materials as described in Section 3-01.4(4). Crushed surfacing and gravel borrow, used in lieu of gravel base, will be measured and paid for as gravel base. In no case shall crushed surfacing, used in lieu of gravel base, be included in any bid items for crushed surfacing.

4-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when shown in the proposal:

"Gravel Base", per tonne, or per cubic meter.

4-04 BALLAST AND CRUSHED SURFACING

4-04.1 Description

This work shall consist of constructing one or more courses of crushed stone upon a prepared subgrade in accordance with these Specifications in conformity with the lines, grades, depth, and typical cross-sections shown in the Plans or as established by the Engineer.

Surfacing materials and ballast may also be specified to be placed in stockpiles for future use.

4-04.2 Materials

Materials shall meet the requirements of the following sections:

Ballast	9-03.9(1)
Shoulder Ballast	9-03.9(2)
Crushed Surfacing	9-03.9(3)
Maintenance Rock	9-03.9(4)

4-04.3 Construction Requirements

4-04.3(1) Equipment

All equipment necessary for the satisfactory performance of this construction shall be on the project and approved by the Engineer prior to beginning work. If central mix plant methods are used, the central mixing plant shall comply with the following requirements:

The cold aggregate feeder shall be mechanically operated and adjustable to the extent necessary to provide a uniform and continuous flow of materials. These materials shall be deposited in an approved mixer with a sufficient amount of water being added to obtain the required density when spread and compacted. The water shall be weighed or metered, and dispensed through a device providing uniform dispersion across the mixer.

The mixing plant shall be provided with weighing or calibrating devices, feeders, provisions for sampling, and other devices and equipment so designed, coordinated, and operated to produce a uniform mixture, and to permit the sampling of the materials before and after mixing. The mixer shall be kept in good condition, and mixing blades or paddles shall be of proper size, adjustment, and clearance to provide positive and uniform mixing of the mixture at all times.

The capacity of the plant and equipment furnished for the work shall be adequate at all times to provide for efficient and continuous operations insofar as practical.

4-04.3(2) Subgrade

The subgrade shall be prepared as specified in Section 2-06 and shall be approved by the Engineer before placing ballast or surfacing materials.

4-04.3(3) Mixing

Unless otherwise specified, the Contractor may use either, or both, of the following described methods:

1. **Central Plant Mix Method.** The surfacing material and water shall be mixed in an approved mixing plant as described in Section 4-04.3(1). The completed mixture shall be a thoroughly mixed combination of proportioned materials and

water, uniform in distribution of particle sizes and moisture content. A mixture containing water in excess of the proportion established by the Engineer will not be accepted.

2. **Road Mix Method.** After material for each layer of surfacing has been placed, the material shall be mixed until uniform throughout by motor graders or other equipment approved by the Engineer. Water to facilitate mixing and compacting shall be added in amounts approved by the Engineer.

4-04.3(4) Placing and Spreading

1. **Central Plant Mix Method.** After mixing, material for each layer of surfacing shall be transported to the roadway in approved vehicles. Vehicles for hauling the mixture shall be capable of depositing the mixture within the receiving hopper of the spreading equipment, or in windrows of uniform size in front of the spreading equipment, with a minimum of segregation of the mix.
   A motor grader may be used as the spreading machine or the spreading machine shall be capable of receiving the material by direct deposit in its hopper from the hauling vehicle or from a uniform windrow, and be capable of spreading and screeding the material to a depth and surface that when compacted will be true to line, grade, depth of course, and cross-section without further shaping.
2. **Road Mix Method.** Each layer of surfacing material shall be spread by equipment that is approved by the Engineer. Equipment that causes segregation of the surfacing material during the spreading operation will not be allowed. Similar types of spreading equipment shall be used throughout the limits of each separate spreading operation. Spreading on small areas of less than 2,000 square meters or on areas irregular in shape, may be accomplished by other means as approved by the Engineer.

The following nominal depth of compacted material shall not be exceeded in any one course without the approval of the Engineer:

Ballast	150 millimeters
Gravel Base	230 millimeters
Crushed Surfacing	100 millimeters

4-04.3(5) Shaping and Compaction

Immediately following spreading and final shaping, each layer of surfacing shall be compacted to at least 95 percent of the standard density determined by WSDOT test method No. 606 before the next succeeding layer of surfacing or pavement is placed. The determination of field in-place density shall be made by the Nuclear gauge. When the thickness of surfacing is less than 45 millimeters, density testing will not be required and the Engineer will determine the number of coverages required for the particular compaction equipment available.

Vibratory compactors and rollers shall obtain the specified density for each layer. A mist spray of water shall be applied as needed to replace moisture lost by evaporation. The completed layer shall have a smooth, tight, uniform surface true to the line, grade, and cross-section shown in the plans, or as staked.

4-04.3(6) Keystone

When necessary, as determined by the Engineer, crushed surfacing top course shall be used for keystone to key the top surface of ballast, gravel base, crushed surfacing base course, or any other surfacing course which requires keying. The keystone shall be spread

evenly on top of the surfacing course by means of approved spreading equipment. The surface shall be watered and, if necessary, bladed lightly until the keystone is worked into the interstices of the surfacing course without excessive displacement and shall be compacted. The operations of adding keystone, wetting, blading, and compacting shall be continued until the course has become thoroughly keyed and compacted.

When keystone is required, that is subject to public traffic, it shall be placed before terminating each day's operation.

Keystone placed for the convenience of the Contractor, with approval of the Engineer, for the purpose of creating a more dense surface on which to pave will be allowed within the top 60 millimeters of crushed surfacing base course, gravel base, or ballast. Keystone placed for this purpose will be paid for at the lower unit contract price for either the base material being keyed or crushed surfacing top course.

4-04.3(7) Miscellaneous Requirements

The surface of each layer of surfacing material shall be maintained true to line, grade, and cross-section by blading, watering, and rolling until placing the next succeeding course. The first course of surfacing material shall be placed on all available subgrade before placing the succeeding course unless otherwise authorized by the Engineer. Unless otherwise approved, there shall be a distance of not less than 25 meters between the construction of any two courses of surfacing or ballast.

Should irregularities develop in any surface during or after compaction, they shall be remedied by loosening the surface and correcting the defects after which the entire area including the surrounding surface shall be thoroughly recompacted. Any additional materials necessary to make the repairs shall be furnished by the Contractor at the unit contract price.

4-04.3(8) Weather Limitations

When, in the opinion of the Engineer, the weather is such that satisfactory results cannot be obtained, the Contractor shall suspend operations until the weather is favorable. No surfacing materials shall be placed in snow or on a soft, muddy, or frozen subgrade.

4-04.3(9) Hauling

Hauling equipment shall be routed over the roadway in a manner to be most effective in the compacting of the surfacing. Hauling over any of the surfacing in the process of construction will not be permitted when, in the opinion of the Engineer, the effect will be detrimental. All loads shall be of uniform capacity unless deviation is expressly authorized by the Engineer.

4-04.3(10) Hours of Work

The Contractor shall arrange surfacing operations so that the placing of materials will be accomplished during daylight hours. However, when necessary to complete the project within the time specified, or to avoid peak periods of public traffic, work may be undertaken during the hours of darkness, provided the Contractor furnishes and operates adequate lighting. Inability to demonstrate reliable and satisfactory results will be reason to order termination of night operations, and the Contractor shall procure additional equipment and personnel necessary to satisfactorily complete the work as specified while operating during daylight hours only.

4-04.3(11) Shoulder Ballast

Shoulder ballast shall not be placed until the abutting pavement has been completed unless designated by the Engineer. Shoulder ballast shall be placed through a spreader box in one lift. Processing of the shoulder ballast course on the roadway will not be permitted. Compaction shall be accomplished by making a minimum of three passes over the aggregate with a vibratory compactor of a type acceptable to the Engineer. The density requirements of Section 4-04.3(5) shall not apply.

4-04.4 Measurement

Crushed surfacing top course, base course, ballast, and gravel base, when mixed at a central plant, will be measured by the tonne. The mass of water added at the plant will be deducted on a daily basis from the total tonneage of aggregates, including water, placed that day which were processed through the central plant and placed on the roadway. The resultant tonneage of surfacing materials will be paid for at the unit contract price. The mass of deducted water will be converted to cubic meters and will be paid for at the unit contract price for water.

Crushed surfacing top course, base course, ballast, and gravel base, when mixed by the road mix method, will be measured by the tonne or by the cubic meter. If measured by the cubic meter, measurement will be made in the hauling conveyance at the point of delivery on the roadway.

Shoulder ballast and crushed surfacing top course used as keystone will be measured by the tonne or by the cubic meter.

Crushed surfacing materials for placement in stockpile will be measured by the tonne or cubic meter. If measured by the cubic meter, the volume will be determined by cross-sectioning the stockpile.

Maintenance rock will be measured in the same manner prescribed for crushed surfacing materials.

Water used in placing and compacting surfacing materials on the roadway will be measured in accordance with Section 2-07.

4-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Crushed Surfacing Top Course (or Base Course)", per tonne, or per cubic meter.

"Crushed Surfacing Top Course (or Base Course) in Stockpile", per tonne, or per cubic meter.

"Crushed Surfacing Top Course (or Base Course) from Stockpile", per tonne, or per cubic meter.

"Ballast", per tonne, or per cubic meter.

"Ballast in Stockpile", per tonne, or per cubic meter.

"Ballast from Stockpile", per tonne, or per cubic meter.

"Shoulder Ballast", per tonne, or per cubic meter.

"Shoulder Ballast in Stockpile", per tonne or per cubic meter.

"Shoulder Ballast from Stockpile", per tonne or per cubic meter.

"Maintenance Rock 12.5 mm Minus in Stockpile", per tonne, or per cubic meter.

4-06 ASPHALT TREATED BASE

4-06.1 Description

Asphalt treated base consists of a compacted course of base material which has been weatherproofed and stabilized by treatment with an asphalt binder.

The work shall consist of one or more courses of asphalt treated base placed on the subgrade in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or as staked.

4-06.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt	9-02.1
Anti-Stripping Additive	9-02.4
Aggregates	9-03.6

The grade of paving asphalt shall be as required in the contract.

4-06.3 Construction Requirements

4-06.3(1) Asphalt Mixing Plant

Asphalt mixing plants for asphalt treated base shall meet the following requirements:

Heating

The plant shall be capable of heating the aggregates to the required temperature.

Proportioning

The mixing plant shall be capable of proportioning: the aggregates to meet the specifications; and the asphalt at the rate specified by the Engineer. If the aggregates are supplied in two or more sizes, means shall be provided for proportioning or blending the different sizes of aggregates to produce material meeting the specification requirements.

Mixing

The mixer shall be capable of producing a uniform mixture of uniformly coated aggregates meeting the requirements of these Specifications.

4-06.3(2) Preparation of Aggregates

Aggregates for asphalt treated base shall be stockpiled before use in accordance with the requirements of Section 3-02.

The aggregates shall be heated as required by the Engineer.

4-06.3(2)A Mix Design

The mix design requirements for asphalt treated base shall be as described in Section 5-04.3(7)A.

4-06.3(3) Heating of Asphalt Material

Heating of the asphalt material shall conform to the requirements of Section 5-04.3(6).

4-06.3(4) Mixing

The asphalt treated base shall be mixed in accordance with the requirements of Section 5-04.3(8).

4-06.3(5) Hauling Equipment

Hauling equipment for asphalt treated base shall conform to the requirements of Section 5-04.3(2).

4-06.3(6) Spreading and Finishing

Asphalt treated base shall be spread with a spreading machine equipped with a stationary, vibratory, or oscillating screed or cut-off device, subject to the approval of the Engineer. Approval of the equipment shall be based on a job demonstration that the finished product will meet all requirements of the specifications. Automatic controls will not be required.

The temperature of the mixture at the time compaction is achieved shall be a minimum of 85°C.

4-06.3(6)A Subgrade Protection Course

Unless otherwise specified by the Engineer, the Contractor shall place the asphalt treated base as a protection for the prepared subgrade on all sections of individual roadways which are to receive asphalt treated base as soon as 10 000 square meters of subgrade is completed. This requirement shall not be limited to contiguous areas on the project.

The surface of the subgrade protection layer when constructed on a grading project shall conform to grade and smoothness requirements that apply to the subgrade upon which it is placed.

4-06.3(6)B Finish Course

The final surface course of the asphalt treated base, excluding shoulders, shall not deviate at any point more than 9 millimeters from the bottom of a 3-meter straightedge laid in any direction on the surface on either side of the roadway crown. Failure to meet this requirement shall necessitate sufficient surface correction to achieve the required tolerance, as approved by the Engineer, at no expense to the Contracting Agency.

When Portland cement concrete pavement is placed on an asphalt base, the surface tolerance of the asphalt base shall be such that no elevation lies more than 16 millimeters below nor 0.0 millimeters above the plan grade minus the specified plan depth of Portland cement concrete pavement. Prior to placing the Portland cement concrete pavement, any such irregularities shall be brought to the required tolerance by grinding or other means approved by the Engineer, at no expense to the Contracting Agency.

4-06.3(7) Density

The asphalt treated base shall be compacted to a density of not less than 80 percent of the maximum theoretical density established for the mix by AASHTO T 209. The density of the base shall be determined by means of tests on cores taken from the roadway or with the nuclear gauge in accordance with Section 5-04.3(10)B. The frequency of these tests shall be at the discretion of the Engineer, but in no case shall it be less than one control lot for each normal day's production. The use of equipment which results in damage to the materials or produces substandard workmanship will not be permitted.

4-06.3(8) Anti-Stripping Additive

An anti-stripping additive shall be added to the asphalt material in accordance with Section 9-02.4, when directed by the Engineer.

4-06.4 Measurement

Asphalt treated base including paving asphalt will be measured by the tonne.

4-06.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Asphalt Treated Base", per tonne.

"Anti-Stripping Additive", by force account.

"Anti-Stripping Additive" will be paid for in accordance with Section 1-09.6 except that no overhead, profit or other costs will be allowed. Payment will be made only for the invoice cost of the additive. The quantity of asphalt material shall not be reduced by the quantity of anti-stripping additive. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

DIVISION 5
SURFACE TREATMENTS AND PAVEMENTS

5-01 SUBSEALING

5-01.1 Description

This work shall consist of filling voids under existing cement concrete pavement by pumping a mixture of Portland cement, pozzolan, and water under the slabs in accordance with these Specifications.

5-01.2 Mix Design

The standard mix design for subsealing is as follows:
1 part (by volume) Portland cement Type I or II
3 parts (by volume) pozzolan (natural or artificial)
2.25 parts (by volume) water

Any deviation from the dry mix portion (Portland cement and pozzolan) shall be approved by the Engineer. The water content may be varied by the Contractor as required for local conditions. Pozzolan shall meet the requirements of ASTM C 618-80 Class C, F, and N.

5-01.3 Construction Requirements

5-01.3(1) Equipment

All equipment used in performance of the work shall be subject to the approval of the Engineer and shall be maintained in satisfactory working condition at all times.

Air compressors to be used for operating air hammers, and for blowing air into the cavities beneath the pavement, shall be of sufficient size and capacity to perform the work to the satisfaction of the Engineer.

Air hammers shall be equipped with drills that are capable of cutting 38 millimeter diameter holes through the pavement. The equipment shall be in good condition and operated in such a manner that out-of-round holes shall not be produced.

The grout plant shall consist of a cement injection pump and a high speed colloidal mixing machine. The colloidal mixing machine shall operate at a minimum speed of 1,200 rpm and shall consist of a rotor operating in close proximity to a stator, creating a high shearing action and subsequent pressure release to make a homogeneous mixture.

The dry material shall be accurately measured, and the water shall be batched through a meter or scale with a totalizer for the day's consumption.

Wooden cylindrical plugs or other devices approved by the Engineer shall be provided to temporarily plug the application holes until the material has set. The plugs shall be slightly tapered on one end for ease in driving.

5-01.3(2) Construction

Subsealing shall not be done when the pavement is wet, or when water is present under the pavement. Application holes shall be drilled through the cement concrete pavement in the approximate pattern as shown in the Plans.

Application holes shall be approximately 38 millimeters in diameter and shall be perpendicular to the pavement surface. Without specific approval of the Engineer, no more application holes shall be drilled during a day's operation than can be filled or temporarily

plugged during the same day. To prepare the cavity for injection of the subsealing mix materials, compressed air shall be blown through the application holes for not less than 15 seconds nor more than 60 seconds, as determined by the Engineer. After the application holes are blown out and the nozzle is firmly wedged into the hole, the subsealing mix shall be pumped into the application hole until all cavities are filled, or until any one of the following occurs:

1. A pavement slab or portion of a slab starts to rise.
2. Subsealing mix extrudes from adjacent application holes, or along or outside the longitudinal edges of the pavement.
3. The Engineer orders application of subsealing mix stopped. After pumping is completed, the nozzle shall not be removed until a worker with a wooden plug is standing by. Immediately upon removal of the nozzle, the plug shall be inserted and firmly driven into the application holes.

Following the application and after it has set, the wooden plugs shall be removed and the application holes immediately filled with subsealing mix.

Subsealing shall be continued progressively through the entire project.

Traffic shall not be allowed to use any subsealed area until the subseal has hardened.

In the event the Engineer determines that continued injection at any specific location is no longer economically feasible, the Contractor shall cease operations and move to a new location. The Contractor will be paid at the unit contract prices for the material used to that point.

5-01.4 Measurement

Measurement will be per each for drill hole for subsealing. Pavement subseal will be measured by the cubic meter (bulk) of dry materials (Portland cement and pozzolan) in bags before the addition of water or other additives.

5-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

1. “Drill Hole for Subsealing”, per each.
2. “Pavement Subseal”, per cubic meter.

5-02 BITUMINOUS SURFACE TREATMENT

5-02.1 Description

This work shall consist of constructing a single or multiple course bituminous surface treatment in accordance with these Specifications and in conformity with the lines and cross-sections shown in the Plans or as designated by the Engineer. During bituminous surface treatment paving operations, temporary raised pavement markings shall be maintained throughout the project. Temporary raised pavement markings shall be installed on the roadway that was paved that day. Temporary raised pavement markings shall be in accordance with Section 8-23.

5-02.1(1) Bituminous Surface Treatment Class A

This method of treatment requires two applications of asphalt and three applications of aggregate as specified. The second application (tack coat) shall be applied not less than ten days after the first application (prime coat) for cutback asphalts and as approved by the Engineer for emulsified asphalts.

5-02.1(2) Bituminous Surface Treatment Classes B, C, and D

These methods require the placing of one application of asphalt and one or more sizes of aggregate as specified to an existing asphalt roadway to seal and rejuvenate the surface and to produce a uniform roadway surface with good nonskid characteristics.

5-02.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt (grade specified)	9-02
Anti-Stripping Additive	9-02.4
Aggregates	9-03.4

Aggregate to be used for bituminous surface treatment shall be of the type and size called for in the Plans or in the proposal.

The particular asphalt to be used on any project shall be that which is called for in the Special Provisions, the proposal, or shown in the Plans, and may be conditionally accepted at the source.

When cutback asphalts are specified or ordered by the Engineer for BST Class A, or for BST Class C used in conjunction with BST Class A, construction shall not begin until the need for anti-stripping additive has been determined. The Contractor shall allow a minimum of seven working days after the necessary aggregate, asphalt, and additive samples have been received in the Headquarter's Materials Laboratory in Tumwater for the necessary tests. Additional time will be required if the Contractor has requested more than one source of asphalt or additive be approved.

5-02.3 Construction Requirements

5-02.3(1) Equipment

The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing and compacting equipment, an asphalt distributor, and equipment for heating asphalt material and shall be subject to approval by the Engineer before its use on the work.

The distributor shall have a capacity of not less than 3.8 cubic meters, and shall be so designed, equipped, maintained, and operated that asphalt material of an even heat shall be uniformly applied at the required rate. It shall be equipped with a 3-meter spray bar with

extensions, pressure pump and gauge, volume gauge so located as to be observed easily by the Inspector from the ground, a tachometer to control accurately the speed and spread of asphalt, and two thermometers, one installed permanently in the tank to indicate temperatures of the asphalt at all times. The power for operating the pressure pump shall be supplied by a power unit which will provide a uniform spray from each of the nozzles across the spray bar and extensions.

Rollers shall be self-propelled pneumatic-tired or smooth-wheeled rollers, each weighing not less than 9 tonnes.

Spreading equipment shall be self-propelled, supported on at least four pneumatic tires, with an approved device for accurately metering and distributing the aggregate uniformly over the roadway surface.

Brooms shall be motorized with a positive means of controlling vertical pressure.

Other equipment necessary to satisfactorily perform the work as specified herein or as designated by the Engineer, shall be subject to approval by the Engineer before its use on the work.

Additional units shall be placed on the work when, in the opinion of the Engineer, it is considered necessary in order to fulfill the requirements of these Specifications, or to complete the work within the time specified.

5-02.3(2) Preparation of Roadway Surface

5-02.3(2)A Untreated Surfaces

The existing roadway surface shall be shaped to a uniform grade and cross-section as shown in the Plans, or as designated by the Engineer.

The roadway shall be sprinkled, bladed, and rolled, after which the top 25 millimeters of dampened material shall be bladed back and forth across the roadway until the entire roadway surface shows a uniform grading from coarse to fine and conforms to the line, grade, and cross-section shown in the Plans or as staked. The entire surface shall then be rolled with a smooth-wheeled or pneumatic-tired roller, or both, as designated by the Engineer, except that the final rolling shall be accomplished with a smooth-wheeled roller as specified in Section 5-02.3(1). Rolling shall continue until the entire roadway presents a firm and unyielding surface.

In the event the compacted aggregates are of such gradation as to resist penetration of the cutback asphalts, the Contractor shall loosen no more than the upper 13 millimeters of surface and relay without compaction immediately before the prime coat application.

No traffic will be allowed on the repaired surface until the prime coat of asphalt and aggregate is applied.

During the operation of blading and rolling, water shall be applied, if necessary, in the amount and at the locations designated by the Engineer.

Immediately before the prime coat of asphalt is applied, the roadway surface shall be stable and unyielding, dry to medium damp condition, free from irregularities and material segregation, and true to line, grade, and cross-section.

5-02.3(2)B Treated Surfaces

The existing bituminous surface shall be swept with a power broom until it is free from dirt or other foreign matter. Hand push brooms shall be used to clean omissions of the power broom. In addition to power and hand brooms, the use of other equipment may be necessary to thoroughly clean the roadway prior to the application of asphalt. Berms created by the removal of dirt or other foreign matter shall be evenly distributed over the remaining shoulder or roadway slope.

As soon as the existing surface has been thoroughly cleaned, all holes in the surface, edges, and edge breaks shall be patched. The holes and breaks shall be thoroughly cleaned of all dirt and loose material. For shallow holes and breaks, a small amount of asphalt shall be placed in the bottom of the hole, covered with aggregate and thoroughly tamped or rolled. For holes 25 millimeters or more in depth, a premix material of aggregate mixed with asphalt as determined by the Engineer shall be used. Asphalt used for patching shall be heated to the temperature specified in Section 5-02.3(3).

Before placing the premix material in the hole, the bottom and edges of the hole shall be swabbed with asphalt. The premixed material shall then be placed and thoroughly tamped or rolled. A small amount of fine screenings shall then be spread on the top of the patch.

Larger depression areas shall be corrected by pre-leveling with premix material or with successive applications of bituminous surface treatment as shown in the Plans or as designated by the Engineer to re-establish a crown-section.

All costs for patching as described above shall be included in the unit contract price per tonne for "Asphalt (grade)" and per cubic meter for "Agg. From Stockpile for BST."

5-02.3(2)C Soil Residual Herbicide

Where shown in the Plans, soil residual herbicide shall be applied in accordance with Section 5-04.3(5)D. All other provisions of Section 5-04 pertaining to soil residual herbicide shall apply.

5-02.3(3) Application of Asphalt

Upon the properly prepared roadway surface, asphalt of the grade specified in the Special Provisions shall be uniformly applied with distributors and specified aggregates spread at the following rates:

	Application Rate		
	Asphalt (L per m^2) Applied	**Aggregate Size (mm)**	**Aggregates (kg per m^2) Applied**
Class A			
Prime Coat	1.6-2.5	12.5-6.3 or 19-12.5	14-22
Tack Coat	1.6-2.3	12.5-6.3	14-16
		6.3-0	2-3
Class B	1.8-2.7	16-6.3	14-22
		6.3-0	2-3
Class C	1.6-2.3	12.5-6.3	11-16
		6.3-0	2-3
Class D	0.9-1.6	9.5-2.0	10-14
Pre Seal	0.7-0.9	6.3-0	4-8

The Engineer will determine the application rates.

Longitudinal joints will be allowed at only the centerline of the roadway, the center of the driving lanes, or the edge of the driving lanes.

To ensure uniform distribution of asphalt, prior to beginning work, the distributor bar shall be operated over a pit or vat. A minimum of 400 liters of material shall remain in the distributor at the end of each shot. To avoid gaps and ridges at transverse junctions of

separate applications of asphalt, the Contractor shall spread sufficient building paper over the treated surface to ensure that the spray jets will be functioning normally when the untreated surface is reached. If ordered by the Engineer, the joints shall be cut back to a neat edge prior to placing the building paper.

Should ridges, overlaps, or gaps occur at transverse joints, the Contractor shall repair the defects to the satisfaction of the Engineer. In lieu of repair the Engineer may elect to accept the completed joints and will deduct from monies due or that may become due the Contractor, the sum of $200 for each joint where the deviations described above are found.

All costs involved in making the corrections to defects described above shall be borne by the Contractor and no payment will be made for this work.

Omissions (skips) by the distributor shall be immediately covered by hand patching with the same grade of asphalt and aggregate used on the project.

The area covered by any one spread of asphalt shall be no more than can be covered with aggregate within one minute from the time of application upon any part of the spread. If field conditions warrant, this time may be increased as designated by the Engineer.

Unless otherwise designated by the Engineer, asphalt shall be spread toward the source of aggregate to avoid injury to the freshly treated surface.

Before they are applied to the roadway, asphalt materials shall be heated to the temperature determined by the Engineer, but within the following limits:

Type and Grade of Asphalt	Distributor Spraying Temperature Min. °C	Max. °C
LIQUID ASPHALTS		
MC, RC70 Viscosity	49	82
MC, RC250 Viscosity	74	104
MC, RC800 Viscosity	93	124
MC, RC3000 Viscosity	110	138
ASPHALT EMULSIONS		
CSS-1, CSS-1h, STE-1	21	60
CRS-1, CRS-2, CMS-2	52	85
CMS-2s, CMS-2h	52	85

5-02.3(4) Change in Grades of Asphalt

At any time during the progress of the work, the Engineer may order the use of other grades of asphalt materials in substitution of the grades specified in the Special Provisions if the intent of the specifications will be better attained.

If the market price of the grade substituted is higher than that of the grade specified, the difference will be added to the unit contract price for asphalt, or if lower, it will be deducted from the unit contract price.

5-02.3(5) Application Method of Aggregates

After the asphalt has been spread evenly over the roadway surface, aggregates of the type specified shall be evenly applied to the roadway surface by spreader equipment.

All aggregate stockpiles shall be watered down to provide aggregates that are uniformly damp at the time of placement on the roadway.

The aggregate shall be spread in one operation in such a manner that a 200-millimeter strip of asphalt is left exposed along the longitudinal joint to form a lap for the succeeding applications of asphalt. If necessary, thin or bare spots in the spread of aggregate shall be corrected by hand spreading or by the use of an approved motor patrol grader equipped with a wire broom moldboard or other methods subject to approval of the Engineer.

A minimum of three rollers shall be used. Two pneumatic-tired rollers shall provide two complete coverages immediately behind the spreading equipment for the coarse aggregate. The third roller which provides the final rolling shall be a smooth wheeled roller for Class A construction over untreated bases. A pneumatic-tired roller shall be used in all other situations.

The maximum rate of roller travel shall be limited to 2.2 meters per second.

The Contractor shall apply fine aggregates to the roadway with additional spreading equipment immediately following the initial rolling of the coarse aggregate unless otherwise specified in the contract documents or ordered by the Engineer. Excess aggregate shall be removed from the roadway.

The operation of trucks hauling aggregate from the stockpile shall be so regulated that no damage, as determined by the Engineer, will result to the highway or the freshly applied asphalt surface.

The completed surface shall be allowed to cure overnight and shall be broomed off the following morning before 10 a.m. If brooming causes rock to be turned or if the Engineer determines that additional cure is needed, the Contractor shall broom the roadway when directed by the Engineer.

If, after completion of the initial brooming, the Engineer determines the need to remobilize for additional brooming, the Contractor shall rebroom the areas designated by the Engineer.

5-02.3(6) Additional Asphalt and Aggregate

If the application of asphalt or aggregate, or both, is insufficient or excessive for the required results, the Engineer may require the Contractor to make an additional application of one or both materials in accordance with these Specifications, or at the direction of the Engineer. Additional asphalt or aggregate used will be paid for at the unit contract prices for the materials used.

5-02.3(7) Patching and Correction of Defects

Omissions by the distributor or damage to the treated surface of any coat shall be immediately covered by hand patching with asphalt in adequate quantities. Holes which develop in the surface shall be patched in the same manner as specified in Section 5-02.3(2)A. All costs incurred by the Contractor, in coating omissions and patching, shall be included in the unit contract prices for the materials used.

Defects such as raveling, lack of uniformity, or other imperfections caused by faulty workmanship shall be corrected and new work shall not be started until such defects have been remedied.

All improper workmanship and defective materials resulting from overheating, improper handling or application, shall be removed from the roadway by the Contractor and be replaced with approved materials and workmanship at no expense to the Contracting Agency.

If the Engineer determines a fog seal is necessary at any time during the life of the contract, the Contractor shall apply a fog seal of CSS-1 at the rate of 0.3 to 0.8 (0.1 to 0.25 residual) liters per square meter. The emulsified asphalt shall be diluted with water at a rate of one part water to one part emulsified asphalt unless otherwise directed by the Engineer.

5-02.3(8) Progress of Work

The Contractor shall organize the work so that progress will be equivalent to at least 5 centerline kilometers work per day of completed prime or tack coat on Class A bituminous surface treatment, or 7 kilometers work per day of completed roadway on Classes B, C, or D bituminous surface treatment. No longitudinal joints shall remain open overnight.

5-02.3(9) Protection of Structures

All bridge handrails, guardrails, curbs, road signs, or other facilities shall be protected from splashing of the asphalt. All costs incurred by the Contractor in necessary protective measures shall be included in the unit contract prices for the various bid items of work involved.

5-02.3(10) Unfavorable Weather

Asphalt shall not be applied to wet material. Subject to the determination of the Engineer, asphalt shall not be applied during rainfall, sand or dust storms, or before any imminent storms that might damage the construction. The Engineer will have the discretion as to whether the surface and materials are dry enough to proceed with construction.

The application of any asphalt to the roadway shall be restricted to the following conditions:

The roadway surface temperature shall be at least 16°C and the air temperature at least 16°C and rising, or

The air temperature shall be not less than 21°C when falling and the wind shall be less than 17 kilometers per hour as estimated by the Engineer.

No asphalt shall be applied which cannot be covered one hour before darkness. The Engineer may require the Contractor to delay application of asphalt until the atmospheric and roadway conditions are satisfactory.

Construction of bituminous surface treatments on any traveled way shall not be carried out before May 15 or after August 15 of any year except upon written order of the Regional Administrator.

5-02.3(11) Anti-Stripping Additive

When requested by the Engineer, an anti-stripping additive shall be added to the asphalt material in accordance with Section 9-02.4.

5-02.4 Measurement

Processing and finishing will be measured by the kilometer to the nearest 0.01 kilometer along the main line roadway. All related supplemental roadways and irregular shaped areas will be incidental.

Asphalt of the grade or grades specified will be measured by the tonne in accordance with Section 1-09.1.

Asphalt for fog seal will be measured by the tonne, before dilution, in accordance with Section 1-09.

Aggregate from stockpile, and furnishing and placing aggregate will be measured by the cubic meter in trucks at the point of delivery on the roadway.

Additional brooming will be measured by the hour.

Water will be measured in accordance with Section 2-07.

5-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Processing and Finishing", per kilometer.

"Asphalt (grade)", per tonne.

"Asphalt for Fog Seal", per tonne.

"Anti-Stripping Additive", by force account.

"Anti-Stripping Additive" will be paid for in accordance with Section 1-09.6 except that no overhead, profit, or other costs will be allowed. Payment will be made only for the invoice cost of the additive. The quantity of asphalt material shall not be reduced by the quantity of anti-stripping additive. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Agg. from Stockpile for BST", per cubic meter.

"Furnishing and Placing Crushed (type)", per cubic meter.

"Additional Brooming", per hour.

"Water", per cubic meter.

If the proposal does not include a bid item for water, the Contractor shall dampen stockpiled or furnished aggregate as required, and the cost thereof shall be included in other items of the work.

5-04 ASPHALT CONCRETE PAVEMENT

5-04.1 Description

This work shall consist of one or more courses of plant mixed asphalt concrete placed on a prepared foundation or base in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or established by the Engineer.

Asphalt concrete shall be composed of asphalt and aggregate which, with or without the addition of mineral filler and blending sand as may be required, shall be mixed in the proportions specified to provide a homogeneous, stable, and workable mixture.

Asphalt concrete Class A, Class B, Class D, Class F, and Class G are designated as leveling or wearing courses. Asphalt concrete Class E is designated as a pavement base course. With the exception of asphalt concrete Class D, all mixtures are considered dense graded asphalt concrete.

5-04.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt Cements	9-02.1(4)
Recycling Agent	9-02.1(5)
Cationic Emulsified Asphalt	9-02.1(6)
Anti-Stripping Additive	9-02.4
Aggregates	9-03.8
Blending Sand	9-03.8(4)
Mineral Filler	9-03.8(5)

The various mineral materials may be furnished in whole or in part by the Contracting Agency for the manufacture of asphalt concrete, or the Contractor may be required to furnish them. If any of these mineral materials are not provided by the Contracting Agency, it shall be understood that the Contractor shall furnish such materials in the amounts required for the designated mix. Mineral materials include coarse and fine aggregates, blending sand, and mineral filler.

The Contractor shall have the option of utilizing asphalt concrete removed under the contract, if any, or old asphalt concrete from an existing stockpile, or supplying all new materials in the production of the asphalt concrete pavement or any combination of the foregoing. If removed from an existing stockpile, the old asphalt concrete used must be uniform in gradation, asphalt content, and asphalt viscosity. If not from an identified and approved source, the aggregates must meet degradation and hardness requirements. Should the Contractor elect to use 20 percent or less of recycled materials, the recycled materials need not be uniform as long as the asphalt concrete meets the specifications for the class specified. A separate mix design will not be required when recycled materials are 20 percent or less. Recycled materials shall not be used in asphalt concrete Class D.

When aggregates or a source for the production of aggregates is provided by the Contracting Agency, the approximate percentage of asphalt required in the mixture for the particular class of pavement will be set forth in the special provisions. The percentage is based upon a midline gradation mix design for the source provided.

The grade of paving asphalt shall be as required in the contract.

Production of aggregates shall comply with the requirements of Section 3-01.

Preparation of stockpile site, the stockpiling of aggregates, and the removal of aggregates from stockpiles shall comply with the requirements of Section 3-02.

5-04.3 Construction Requirements

5-04.3(1) Asphalt Mixing Plant

Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the plant except that aggregates produced meeting the requirements of Section 9-03.8(3)B need not be separated. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

Plants used for the preparation of asphalt concrete shall conform to all requirements of Section 5-04.3(1)A except that scale requirements shall apply only where weight proportioning is used. In addition, batch plants shall conform to the requirements of Section 5-04.3(1)B; continuous mix plants shall conform to the requirements of Section 5-04.3(1)C; and rotary drum plants shall conform to the requirements of Section 5-04.3(1)D.

5-04.3(1)A Requirements for All Plants

Except as noted in Section 5-04.3(1)E, all plants shall meet the following requirements:

1. The asphalt plant shall have a minimum capacity rating by the manufacturer as follows:
   For projects involving 5,000 tonnes or more:
   Batch plants — 900 kilograms per batch.
   Continuous mix and rotary drum plants — 90 tonnes per hour.
   For projects involving less than 5,000 tonnes:
   Batch plants — 450 kilograms per batch.
   Continuous mix and rotary drum plants — 40 tonnes per hour.
2. Smoke and dust control. When the asphalt plant is erected at a site for the primary purpose of producing mixtures for a specific project, dust and smoke from the asphalt plant shall be eliminated to the extent that they will cause no inconvenience to property owners in the area or damage to their property. The Contractor shall be required to install supplemental equipment, when necessary, to control the dust and smoke to meet the requirements of Section 1-07.1.
3. Scales. Plant and truck scales shall meet the requirements of Section 1-09.2.
4. Equipment for preparation of asphalt material. Tanks for the storage of asphalt material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the asphalt material shall be designed to ensure proper and continuous circulation during the operating period. Provision shall be made for measuring the asphalt in the storage tank and a valve shall be placed in the supply line to the mixer for sampling the material.
5. Feeder for drier or drum mixer. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained. The feeder for blending sand, when required, shall be capable of providing a consistent, uniform flow in the amount designated by the Engineer.
6. Screens. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

7. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to ensure separate and adequate storage of appropriate fractions of the aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, sized and located to prevent material backing up into other compartments or bins. Each compartment shall be provided with an outlet gate, constructed so there shall be no leakage when closed. The gates shall close quickly and completely. Bins shall be constructed so samples can be readily obtained. Bins shall be equipped with adequate tell-tale devices to indicate the level of the aggregates in the bins at the lower quarter points.
8. Asphalt control unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of asphalt material in the mix. Means shall be provided for checking the quantity or rate of flow of asphalt material into the mixer.

   The asphalt may also be proportioned by a device which sprays the asphalt into the mixer through six or more nozzles, and which weighs or proportions the material for each batch by a positive rotating meter which is calibrated in pounds. The metering device shall have an established background of service and shall be approved by the Engineer.
9. Thermometric equipment. An armored thermometer of adequate range in temperature reading shall be fixed in the asphalt feed line at a suitable location near the charging valve at the mixer unit.

   The plant shall also be equipped with either an approved dial-scale, a mercury actuated thermometer, an electric pyrometer, or other approved thermometric instrument placed at the discharge chute of the drier to automatically register or indicate the temperature of the heated aggregates. This device shall be in full view of the plant operator. The Engineer may require replacement of any thermometer with an approved temperature-recording apparatus for better regulation of the temperature of aggregates.
10. Dust collector. The plant shall be equipped with a dust collector constructed to waste or return uniformly to the hot elevator all or any part of the material collected.

    When a baghouse is used for dust control, the Contractor shall be able to introduce the material returned from the baghouse into the mixture at a uniform and continuous rate. Accurate mechanical means shall be provided for uniformly feeding the fines into the aggregate stream. To accomplish this, the Contractor shall provide a surge hopper with a holding capacity sufficient to accumulate the baghouse fines or shall have a variable speed mechanical feed interlocked to the plant which will prevent any variance in feed into the aggregate stream. Either method shall provide uniform and continuous return of the well-graded fine materials and be provided with a method of withdrawing the surplus fines independently for disposal.
11. Burner fuel. The plant burner fuel shall be restricted to the use of propane, butane, natural gas, methane, coal, No. 1 or No. 2 fuel oil, or other acceptable burner fuel as determined by the Engineer.

5-04.3(1)B Requirements for Batch Plants

In addition to the requirements listed under Section 5-04.3(1)A, batch plants shall meet the following requirements:

1. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process, and be capable of preparing aggregates to specification requirements.
2. Weigh box or hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.
3. Asphalt control. The equipment used to measure the asphalt material shall be accurate to plus or minus 0.5 percent. The asphalt bucket shall be a nontilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than 75 percent of the length of the mixer and it shall discharge directly into the mixer. The asphalt bucket, its discharge valve or valves and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be constructed so they will not interfere with the efficient operation of the asphalt scales. The capacity of the asphalt bucket shall be at least 15 percent in excess of the mass of asphalt material required in any batch. The plant shall have an adequately heated quick-acting, nondrip, charging valve located directly over the asphalt material bucket.

   The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of asphalt material used in a batch. The controls shall be constructed so they may be locked at any dial setting and will automatically reset to that reading after the addition of asphalt material to each batch. The dial shall be in full view of the mixer operator. The flow of asphalt material shall be automatically controlled so it will begin when the dry mixing period is over. All of the asphalt material required for one batch shall be discharged in not more than 15 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of asphalt material the full length of the mixer. The section of the asphalt line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for an asphalt material bucket.
4. Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture meeting the requirements of these Specifications. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust.

   Clearance of the blades from all fixed and moving parts shall not exceed 25 millimeters unless the maximum diameter of the aggregate in the mix exceeds 38 millimeters, in which case the clearance shall not exceed 38 millimeters.
5. Mixing time. The plant shall be capable of regulation of the mixing time as specified in Section 5-04.3(8) in 5 second increments.
6. Automatic controls. All projects using a batch mixer involving 5,000 tonnes or more of asphalt concrete, shall conform to the following provisions. Automatic control of batch mixing operations may be used providing the requirements of this section are met.

The proportioning and timing devices shall be automatic to the extent that the only manual operation required for the proportioning and mixing of materials for one batch shall be a single operation of a switch or starter.

The mixing plant shall be equipped with automatic mass proportioning devices to monitor and control the masses of the several components of aggregates and of the asphalt, plus timing lock devices to monitor and control the position of the aggregate weigh hopper dump gate, the asphalt bucket discharge valve, and the mixer discharge gate.

Withdrawal from the aggregate bins and the discharge of the weigh hopper shall be so interlocked that the weigh hopper cannot discharge until the required quantity of aggregate from each bin has been deposited therein. The weigh hopper may be a single compartment, individual mass control type, or of the divided compartment, preset volume type. When the single compartment, individual mass control type is used, the automatic scale mass system shall discharge and weigh material from one bin at a time. When the preset volume weigh hopper is used, the automatic control system shall check the total mass of each aggregate batch and provision shall be made to allow the Engineer to check easily and quickly the individual aggregate masses at any time.

The timing lock devices shall be actuated by the opening of the aggregate weigh hopper dump gate. They shall lock the asphalt bucket discharge valve until preset dry mixing time is expired and shall lock the mixer discharge gate throughout the preset dry and wet mixing periods. The control of the timing shall be flexible and capable of being set at intervals of not more than 5 seconds throughout cycles up to 60 seconds.

The dials of the timing locks and automatic weighing controls shall be so arranged that the time interval and mass proportion controls may be locked by the Engineer.

5-04.3(1)C Requirements for Continuous Mix Plants

In addition to the requirements listed under Section 5-04.3(1)A, continuous mix plants shall meet the following requirements:

1. Aggregate proportioning. The plant shall include a means for accurately proportioning each size of aggregate.

   The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means provided with a lock.

   Indicators shall be provided for each gate to show the respective gate opening in millimeters.

   The feeder belt or drive system shall be adjustable to various speeds and calibrated with various gate openings for the material to be used.
2. Mass calibration of aggregate feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provision shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples weighing not less than 90 kilograms.

3. Synchronization of aggregate feed and asphalt material feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of asphalt material from the meter or other proportioning device. This control shall be accomplished by interlocking mechanical means or by any other positive method satisfactory to the Engineer.

   A warning device shall be provided to alert the plant operator any time the level of material in any one bin is so low that uniform feed is discontinued.
4. Mixer. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture meeting the requirements of these Specifications. It shall be equipped with a discharge hopper with dump gates which will permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed of aggregate per minute for the aggregate being used.

5-04.3(1)D Requirements for Rotary Drum Plants

In addition to the requirements listed under Section 5-04.3(1)A, rotary drum plants shall meet the following requirements:

1. The plant shall have a feeder capable of uniformly introducing the aggregate into the drum. The aggregate feeder shall be synchronized with the asphalt material feed. Satisfactory means shall be provided to afford positive interlocking control between each aggregate cold feed bin, aggregate feed, and the asphalt feed so the plant will automatically activate a warning device if the feed of either aggregate or asphalt is interrupted.
2. The plant shall have the mixing capability to provide a uniform mixture meeting the requirements of these Specifications.
3. The asphalt material feed shall have positive recording capabilities so the amount of asphalt incorporated into the mix during any given period of time may be read directly.

5-04.3(1)E Screenless Plants

If the Contractor elects to produce aggregate in accordance with Section 9-03.8(3)B, Item 6 — Screens and Item 7 — Bins of Section 5-04.3(1)A will not be required provided the completed mixture meets the specifications as listed in Section 9-03.8(6) for the class of mix being produced.

5-04.3(2) Hauling Equipment

Trucks used for hauling asphalt concrete mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, or other approved material to prevent the mixture from adhering to the beds. Each truck shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from the weather.

When dump truck beds are sprayed with oil, the excess oil shall be drained prior to filling with the asphalt mixture. For hopper trucks, the conveyer shall be in operation during the process of oiling the bed.

5-04.3(3) Asphalt Pavers

Asphalt pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of asphalt plant mix material in lane widths applicable to the specified typical section and thicknesses shown in the Plans.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating, or gouging the mixture. Any bolt-on or hydraulic extensions shall produce the same results including ride, density, and surface texture as the screed or strike off assembly. Hydraulic extenders without screeds, augers, and vibration shall not be used in the traveled way.

When laying mixtures, the paver shall be operated at a uniform forward speed consistent with the plant production rate and roller train capacity to result in a continuous operation. The auger speed and flight gate opening shall be adjusted to coordinate with the operation.

The paver shall be equipped with automatic screed controls with sensors for either or both sides of the paver. The controls shall be capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing automatic signals which operate the screed to maintain the desired grade and transverse slope. The sensor shall be constructed so it will operate from a reference line or a multi-footed ski-like arrangement.

The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

Manual operation will be permitted in the construction of irregularly shaped and minor areas. These areas, as determined by the Engineer, may include, but are not limited to, gore areas, road approaches, left-turn channelizations, and tapers.

When specified in the contract, reference lines will be required for both outer edges of the traveled way for each main line roadway for vertical control. Horizontal control utilizing the reference line will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference lines or by means of a multi-footed ski and a slope control device. When the finish of the grade prepared for paving is superior to the established tolerances, and, when in the opinion of the Engineer, further improvement to the line, grade, cross-section, and smoothness can best be achieved without the use of the reference line, a multi-footed ski-like arrangement may be substituted subject to the continued approval of the Engineer. After paving the first lane, a joint matcher may be used subject to the approval of the Engineer. The use of the reference line shall be reinstituted immediately whenever the Contractor fails to maintain a superior pavement, or rhythmic undulations occur, or the surface smoothness of the course being paved fails to meet the requirements for wearing course. The reference line may be removed after the completion of the first course of asphalt concrete when approved by the Engineer and subject to reinstallation at the Contractor's expense.

The Contractor shall furnish and install all pins, brackets, tensioning devices, wire, and accessories necessary for satisfactory operation of the automatic control equipment. The Contractor shall submit samples of the above items along with the methods and procedures to the Engineer for approval prior to installation.

5-04.3(4) Rollers

Rollers shall be of the steel wheel, vibratory, or pneumatic tire type, in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the mixture. The number and mass of rollers shall be sufficient to compact the mixture as required in Section 5-04.3(10). The use of equipment which results in excessive crushing of the aggregate will not be permitted. Rollers producing pickup, washboard, uneven compaction of the surface or other undesirable results will be rejected by the Engineer.

The following specifications shall apply to the various types of rollers:

1. Vibratory Rollers
   a. A variable amplitude will be required, with at least 2 settings.
   b. A variable frequency with a 2,000 VPM minimum.
   c. The maximum rate of travel under vibration shall be limited to 1.3 meters per second.
   d. Pneumatic propulsion on surface courses shall be limited to smooth tires that will not leave visible tracks.
2. Pneumatic Tired Rollers
   a. The maximum rate of travel shall be limited to 2.2 meters per second.
   b. Skirts shall be firmly affixed to the perimeter of the roller and shall uniformly extend to within 25 millimeters of the pavement surface.
3. Steel Wheel Rollers
   a. The maximum rate of travel shall be limited to 1.75 meters per second.

5-04.3(5) Conditioning of Existing Surface

When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross-section as approved by the Engineer.

Preleveling of uneven or broken surfaces over which asphalt concrete is to be placed is required and may be accomplished by using the specified asphalt concrete placed with an asphalt paver, a motor patrol grader, or by hand raking, as approved by the Engineer. When asphalt concrete pavement Class G is being constructed as a wearing course overlay, upon approval of the Engineer, asphalt concrete pavement Class A or Class B may be used as an alternate for preleveling, provided there is no increase in cost to the Contracting Agency for preleveling.

After placement, the asphalt concrete used for preleveling shall be compacted thoroughly.

5-04.3(5)A Preparation of Existing Surfaces

Before construction of an asphalt concrete pavement on an existing paved surface, all fatty asphalt patches, grease drippings, and other objectionable matter shall be entirely removed from the existing pavement. All excess asphalt joint filler shall be completely removed and all premolded joint filler shall be removed to at least 13 millimeters below the surface of the existing pavement. All types of existing pavement or bituminous surfaces shall be thoroughly cleaned by sweeping to remove dust and other foreign matter.

A tack coat of asphalt applied at the rate of 0.1 to 0.35 liters per square meter of retained asphalt shall be applied to all paved surfaces on which any course of asphalt concrete is to be placed or abutted. The spreading equipment shall be equipped with a spray bar with extensions, pressure pump and gauge, tachometer to accurately control the speed and the spread of asphalt, a thermometer to indicate the temperature of the asphalt, and hand

operated spray equipment for use only on inaccessible and irregularly shaped areas. The power for operating the pressure pump shall be supplied by a power unit which will develop a minimum of 175 kilopascals at the spray bar. When asphalt concrete pavement Class D is being constructed, a tack coat of CRS-2 shall be applied to the existing surface at a rate of 0.55 to 0.9 (0.35 to 0.55 residual) liters per square meter or as otherwise ordered by the Engineer.

The tack coat shall be a heated cutback asphalt, or emulsified asphalt, mixing grade, as directed by the Engineer. The emulsified asphalt may be diluted with water at a rate not to exceed one part water to one part of emulsified asphalt, as directed by the Engineer.

When asphalt concrete pavement is to be constructed over an existing paved or oiled surface, in addition to the preparation as outlined above, all holes and small depressions shall be filled with an appropriate class of asphalt concrete mix. The surface of the patched area shall be leveled and compacted thoroughly.

5-04.3(5)B Preparation of Untreated Roadway

The existing roadway shall be prepared and the roadway primed as provided in Section 5-02.3(2)A, except that only one application of asphalt and one application of aggregate, which shall conform to aggregate for asphalt concrete Class B as listed in Section 9-03.8 or other granular materials approved by the Engineer, will be required. All other provisions of Section 5-02 pertaining to bituminous surface treatment Class A shall apply, except as hereinafter modified.

The prime coat shall be applied over the full length of the project, and asphalt concrete pavement shall not be placed until the prime coat has cured for 5 days unless otherwise approved by the Engineer.

Should any holes, breaks, or irregularities develop in the roadway surface after the prime coat has been applied, they shall be patched with asphalt concrete, as described in Section 5-04.3(5)A, in advance of placing the asphalt concrete. The Contractor shall maintain the completed prime coat by blading or brooming with motor patrol graders, as approved by the Engineer, until the asphalt concrete is placed.

After the maintenance, patching or repair work has been completed and immediately prior to placing the asphalt concrete pavement, the surface of the prime coat shall be swept clean of all dirt, dust, or other foreign matter.

When the prime coat application is not specified in the Special Provisions or shown in the Plans, the Contractor shall prepare the untreated roadway as described above and shall omit the prime coat treatment. The asphalt concrete pavement shall be constructed on the prepared subgrade.

In areas used as turnouts or which will receive heavy service, the Engineer may order a change in the grade to provide a greater depth of pavement.

The Contractor shall prepare untreated shoulders and traffic islands by blading and compacting to provide a sound base for paving and shall omit the prime coat treatment. The asphalt concrete pavement shall be constructed on the prepared subgrade.

If the Contractor protects the completed untreated surfacing materials to the degree that the surface meets the requirements of Section 5-02.3(2)A at the time of construction of the prime coat or the construction of the pavement if the prime coat is not required, the Contractor will not be required to perform the work specified in Section 5-02.3(2)A but shall be compensated for the item of work preparation of untreated roadway.

5-04.3(5)C Crack Sealing

When the proposal includes a pay item for crack sealing, all cracks and joints 6 millimeters and greater in width shall be cleaned with a stiff-bristled broom and compressed air. Cracks and joints greater than 6 millimeters and less than 19 millimeters in width shall be filled with either a sand slurry or rubberized asphalt. Cracks larger than 19 millimeters in width shall be filled with a sand slurry. Application of the sand slurry or rubberized asphalt shall be as follows:

1. Sand Slurry. The sand slurry shall consist of approximately 20 percent CSS-1 emulsified asphalt, approximately 2 percent Portland cement, water (if required), and the remainder clean 6 millimeter-0 paving sand. The mixture shall be poured into the cracks and joints until full. The following day, any cracks or joints which are not completely filled shall be topped off with the slurry. After sealing, the filler shall be broomed or squeegeed flush with the existing pavement surface and allowed to cure prior to constructing the asphalt concrete overlay.
2. Rubberized Asphalt. The sealant material shall conform to the requirements of Section 9-04.10 and shall be applied in accordance with the manufacturer's recommendations. These recommendations shall be furnished to the Engineer by the Contractor prior to the start of work and shall include recommended heating time and temperature, allowable storage time and temperatures after initial heating, allowable reheating criteria, and application temperature range.

   The cracks shall be completely dry before being filled with the rubberized asphalt. Filling shall be controlled to confine the material within the crack or joint. If, in the opinion of the Engineer, the Contractor's method of filling results in an excessive amount of sealant on the pavement surface, filling shall be stopped and the method changed. Any overflow shall be cleaned from the pavement surface.

5-04.3(5)D Soil Residual Herbicide

Where shown in the Plans, the Contractor shall apply one application of an approved soil residual herbicide. Paving shall begin within 24 hours after application of the herbicide. Any area that has not been paved within the time limit or that has been rained on, shall be treated again at the Contractor's expense. The herbicide shall be applied uniformly in accordance with the manufacturer's recommendations.

The material to be used shall be registered with the Washington State Department of Agriculture for use under pavement. Before use, the Contractor shall receive approval of the material to be used and the proposed rate of application, from the Engineer. The following information shall be included in the request for approval of the material: Brand name of the material, manufacturer, Environmental Protection Agency (EPA) registration number, material safety data sheet, and proposed rate of application.

Application of the herbicide shall be performed in accordance with Section 8-02.3(2)A.

5-04.3(5)E Pavement Repair

The Contractor shall excavate, furnish, and place asphalt concrete pavement as backfill for pavement repair areas in accordance with the details shown in the Plans and as staked.

The actual excavation depth may vary to a maximum depth of 0.3 meter maximum, depending upon where stable foundation material is encountered, as determined by the Engineer.

The minimum width of any pavement repair area shall be 1 meter unless shown otherwise in the Plans. All pavement repair areas shall be sawcut before removal, or shall be removed by a pavement grinder approved by the Engineer.

Asphalt for tack coat shall be required as specified in Section 5-04.3(5)A, and shall be applied to all edges of existing pavement in the pavement repair area.

The Contractor shall excavate only within one lane at a time. The areas shall be excavated, backfilled, and compacted within the same day's working shift, in accordance with the details shown in the Plans and to the satisfaction of the Engineer.

Excavated materials will become the property of the Contractor for disposal off the right of way.

The Contractor shall conduct the excavation operations in a manner that will protect the pavement areas not designated to be removed. Pavement not designated to be removed that is damaged as a result of the Contractor's operations shall be repaired by the Contractor to the satisfaction of the Engineer at no cost to the Contracting Agency.

Placement of the asphalt concrete backfill shall be accomplished in lifts. Each lift shall not exceed 100 millimeters compacted depth. Compaction shall be accomplished by mechanical tamper or a roller as approved by the Engineer.

Asphalt concrete pavement for pavement repair shall be asphalt concrete pavement Class A, B, E, or F at the Contractor's option, unless otherwise specified in the contract.

5-04.3(6) Heating of Asphalt Material

The asphalt shall be heated to a maximum of 177°C. At the Contractor's request, the maximum temperature may be increased by the Engineer as recommended by the asphalt cement manufacturer. The asphalt shall be heated in a manner that will avoid local overheating and provide a continuous supply of asphalt material to the mixer at a uniform temperature plus or minus 14°C from the temperature ordered by the Engineer.

5-04.3(7) Preparation of Aggregates

The aggregates shall be stockpiled according to the requirements of Section 9-03.8(3). The aggregates shall be removed from stockpile(s) in a manner to ensure a minimum of segregation when being moved to the asphalt plant for processing into the final mixture.

5-04.3(7)A Mix Design

The Contractor shall obtain representative samples from mineral aggregate stockpiles, blend sand and RAP sources to be used for ACP production, submitting them for development of a mix design. Sample submittal shall include asphalt oil sources and the production mix gradation and combining ratios of mineral aggregate stockpiles, blend sand and RAP that will be used and this will be the basis for the mix design and job mix formula. When RAP in excess of 20 percent is used, the mix design will be based upon the requirements of Section 9-03.8(2) for the specification class of ACP or as shown in the Special Provisions. In addition for a RAP mix design the blend of recovered paving asphalt plus recycling agent and additional paving asphalt shall meet the requirements of the paving asphalt specified in the contract. Adjustments to the Job Mix Formula may be made per Section 9-03.8(6)A. The Contractor shall allow 15 working days for this approval and design once the material has been received at the Materials Laboratory. Additional time may be required if the proportions will not make an adequate design as determined by the Engineer, or if the Contractor requests more than one recycling agent or paving asphalt source approval. The Contractor is also advised that production of the asphalt concrete shall not commence until the job mix design has been established.

The Contractor shall obtain the Engineer's approval prior to changing the source of asphalt cement during the production of asphalt concrete. Blending of asphalt from different sources will not be permitted.

5-04.3(8) Mixing

The prepared aggregates shall be combined in the mixer in the amount of each fraction of aggregates as specified or as directed by the Engineer. The asphalt material shall be measured or gaged and introduced into the mixer in the amount determined by the Engineer.

After the required amounts of aggregate and asphalt material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt material throughout the aggregate is ensured. Wet mixing time shall be sufficient to produce 95 percent coated particles as determined by WSDOT Test Method No. 714.

When discharged, the temperature of the mix shall not exceed 163°C except that the temperature for mixes designed for asphalt concrete Class D shall not exceed 127°C. At the discretion of the Engineer, a higher maximum discharge temperature may be allowed if the asphalt cement manufacturer specifically recommends a mixing temperature that exceeds these maximums. A maximum water content of 2 percent in the mix, at discharge, will be allowed providing the water causes no problems with handling, stripping, or flushing. In this case, the moisture content shall be reduced as directed by the Engineer.

Storing or holding of the asphalt concrete mixture in approved storage facilities will be permitted during the daily operation but in no event shall the materials be held for more than 24 hours. Materials held for more than 24 hours after mixing shall be rejected and disposed of by the Contractor at no expense to the Contracting Agency. The storage facility shall have a visible device located at the top of the cone or about the third point to indicate the amount of material in storage. No material shall be accepted from the storage facility when the material in storage is below the top of the cone of the storage facility, except at the end of the working day.

5-04.3(8)A Acceptance Sampling and Testing

1. General. Acceptance of asphalt cement concrete shall be as provided under statistical or nonstatistical acceptance. Determination of statistical or nonstatistical acceptance shall be based on proposal quantities and shall consider the total of all bid items involving mix of a specific class.

   Dense graded mixes (asphalt concrete pavement Classes A, B, E, F, and G) will be evaluated for quality of gradation and asphalt content.

   Open graded mixes (asphalt concrete pavement Class D) will be evaluated for quality of gradation only, based on samples taken from the cold feed.

   Statistical acceptance procedures will apply only to contracts advertised, awarded, and administered by WSDOT, unless specifically provided otherwise in the Special Provisions. Contracting agencies other than WSDOT must specifically invoke statistical acceptance in their Special Provisions if it is desired.

   Statistical Acceptance, (1) applies only to WSDOT projects, (2) is administered under the provisions of Section 5-04.5(1) for Quality Assurance Price Adjustments and evaluation of quality, and (3) will be used for a class of mix when the proposal quantities for that class of mix exceed 2,500 tonnes.

   Nonstatistical Acceptance will be used, (1) for a class of mix when the proposal quantities for that class of mix are less than 2,500 tonnes, and (2) all contracts advertised, awarded, and administered by agencies other than WSDOT.

2. Aggregates. Aggregates will be accepted for sand equivalent and fracture based on their conformance to the requirements of Section 9-03.8(2) without recourse to statistical evaluation.
3. Asphalt Concrete Mixture
   A. Sampling
      (1) A sample will not be obtained from either the first or last 25 tonnes of mix produced in each production shift.
      (2) Samples for compliance of gradation and asphalt cement content will be obtained on a random basis from the hauling vehicle. The Contractor shall provide adequate platforms to enable samples to be obtained in accordance with WSDOT Test Method 712. The platforms shall allow the sample to be taken without the Engineer entering the hauling vehicle.
   B. Definition of Sampling Lot and Sublot. For the purpose of acceptance sampling and testing, a lot is defined as the total quantity of material or work produced for each job mix formula (JMF), placed and represented by randomly selected samples tested for acceptance. All of the test results obtained from the acceptance samples shall be evaluated collectively and shall constitute a lot. Only one lot per JMF will be expected to occur. The JMF (Job Mix Formula) is defined in Section 9-03.8(6)A (Basis of Acceptance).

      The Contractor may request a change in the JMF. If the request is approved, all of the material produced up to the time of the change will be evaluated on the basis of available tests and a new lot will begin. The quantity represented by each sample will constitute a sublot. Sampling and testing for statistical acceptance shall be performed on a random basis at the frequency of one sample per sublot, with a minimum of five sublots per class of mix. Sublot size shall be determined to the nearest 100 tonnes to provide not less than five uniform sized sublots, based on proposal quantities, with a maximum sublot size of 800 tonnes.

      Sampling and testing for nonstatistical acceptance shall be performed on a random basis at a minimum frequency of one sample for each sublot of 400 tonnes or each day's production, whichever is least. When proposal quantities exceed 1,200 tonnes for a class of mix under nonstatistical acceptance, sublot size shall be determined to the nearest 100 tonnes to provide not less than three uniform sized sublots, based on proposal quantities, with a maximum sublot size of 800 tonnes.
   C. Test Results. The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed in the field by 7:00 a.m. the morning of the next workday after sampling, or for nighttime work within four hours after the beginning of the next paving shift. The Engineer will also provide, by noon of the next workday after sampling, the Composite Pay Factor (CPF) of the completed sublots after three sublots have been produced.

      Individual acceptance sample test results (gradation and asphalt content) may be challenged by the Contractor. A written challenge of the test results by the Contractor shall be received by the Project Engineer within five working days after receipt of the specific test results. A split of the original acceptance sample shall be sent, for testing, to the Region Materials

Lab or to OSC Materials Lab as determined by the Engineer. The challenged sample will not be tested with the same equipment or by the same tester that ran the original acceptance sample. The challenge sample will be tested for a complete gradation analysis and asphalt content.

The results of the challenge sample will be compared to the original results of the acceptance sample test and evaluated according to the following criteria:

	Deviation
4.75 mm sieve and larger	±4 percent
3.35 mm sieve to 0.180 mm sieve	±2 percent
0.150 mm and 0.075 mm sieve	±0.4 percent
Aphalt %	±0.3 percent

If the deviation of the challenge sample is within each parameter established, the acceptance sample will be used to determine to composite pay factor and the cost of testing will be deducted from any monies due or that may come due the Contractor under the contract, at the rate of $200 per test.

If the deviation of the challenge sample is outside of any one parameter established, the challenge sample will be used to determine the composite pay factor and the cost of testing will be the Contracting Agency's responsibility.

D. Test Methods. Acceptance testing for compliance of asphalt content will use the Nuclear Asphalt Gauge Procedure; WSDOT Test Method 722-T. Acceptance testing for compliance of gradation will use the Quick Determination of Aggregate Gradation using Alternate Solvent Procedure; WSDOT Test Method 723-T.

At the option of the Engineer, the Contracting Agency may substitute the following test procedures for acceptance testing for asphalt content and gradation:

Field Operating Procedure for AASHTO TP 53 Method A
Field Operating Procedure for AASHTO T-30

E. Reject Mixture

(1) Rejection by Contractor. The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. Any such new material will be sampled, tested, and evaluated for acceptance.

(2) Rejection Without Testing. The Engineer may, without sampling, reject any batch, load, or section of roadway that appears defective in gradation or asphalt cement content. Material rejected before placement shall not be incorporated into the pavement. Any rejected section of roadway shall be removed.

No payment will be made for the rejected materials or the removal of the materials unless the Contractor requests that the rejected material be tested. If the contractor elects to have the rejected material tested, a minimum of three representative samples will be obtained and tested. Acceptance of rejected material will be based on conformance with the statistical acceptance specification. If the CPF for the rejected material

is less than 0.75, no payment will be made for the rejected material, and in addition, the cost of sampling and testing shall be borne by the Contractor. However, if the CPF is greater than 0.75, the cost of sampling and testing will be borne by the Contracting Agency and the mix will be compensated at a CPF of 0.75. If rejection occurs after placement and the CPF is greater than 0.75, compensation for the rejected mix will be at a CPF of 0.75 with an addition of 10 percent of the unit contract price added for placement and removal costs.

(3) A Partial Sublot. In addition to the preceding random acceptance sampling and testing, the Engineer may also isolate from a normal sublot any material that is suspected of being defective in gradation or asphalt cement content. Such isolated material will not include an original sample location. A minimum of three random samples of the suspect material will be obtained and tested. The material will then be evaluated for price adjustment in accordance with the statistical acceptance section. This material will be considered a separate lot. When the isolated material overlaps the division between materials sublots, the resulting two adjoining partial sublots will be combined into a single lot with a minimum of six random samples.

(4) An Entire Sublot. If an entire sublot is rejected in accordance with Section 1-06.2, four additional random samples from this sublot will be obtained and the sublot evaluated as an independent lot with the original test result included as a fifth test with the new independent lot instead of with the original lot.

(5) A Lot in Progress. The Contractor shall shut down operations and shall not resume asphalt concrete placement until such time as the engineer is satisfied that specification material can be produced whenever the Composite Pay Factor (CPF) for a lot in progress:

a. Drops below 1.00 and the Contractor is taking no corrective action, or

b. Is less than 0.75.

(6) An Entire Lot. An entire lot with a CPF of less than 0.75 will be rejected. The designated percentage reduction as defined in Section 1-06.2(2)B under Financial Incentive Paragraph 1, Item 3, shall be 25 percent.

5-04.3(9) Spreading and Finishing

The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. Asphalt pavers complying with Section 5-04.3(3) shall be used to distribute the mixture. Unless otherwise directed by the Engineer or specified in the Plans or in the Special Provisions, the nominal compacted depth of any layer of any course shall not exceed the following depths:

Asphalt Concrete Class E	105 millimeters
Asphalt Concrete Class A and B when used for Base Course	105 millimeters
Asphalt Concrete Class A, B, and F	75 millimeters
Asphalt Concrete Class G	30 millimeters
Asphalt Concrete Class D	30 millimeters

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other equipment or by hand.

The placing of asphalt mixtures at night will not be permitted except by approval of the Engineer or if specified in the Special Provisions.

When the asphalt mixture is being produced by more than one asphalt plant, the material produced by each plant shall be placed by separate spreading and compacting equipment.

5-04.3(10) Compaction

5-04.3(10)A General

Immediately after the asphalt concrete mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, or irregularities and in conformance with the line, grade, and cross-section shown in the Plans or as established by the Engineer. If necessary, the mix design may be altered to achieve desired results.

Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. All compaction units shall be operated at the speed, within specification limits, that will produce the required compaction. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any asphalt concrete that becomes loose, broken, contaminated, shows an excess or deficiency of asphalt, or is in any way defective, shall be removed and replaced at no additional cost with fresh hot mix which shall be immediately compacted to conform with the surrounding area.

The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided specification densities are attained. An exception shall be that the pneumatic tired roller shall be used between October 1 and April 1. Coverages with a vibratory or steel wheel roller may precede pneumatic tired rolling. When asphalt concrete pavement Class D is being constructed, the use of pneumatic rollers will not be required.

Vibratory rollers shall not be operated in the vibratory mode when the internal temperature of the mix is less than 79°C without permission of the State Construction Engineer. In no case shall a vibratory roller be operated in a vibratory mode when checking or cracking of the mat occurs at a greater temperature. Vibratory rollers in the vibratory mode are also prohibited on bridge decks.

5-04.3(10)B Control

Asphalt concrete pavement Classes A, B, E, and F used in traffic lanes, including lanes for ramps, truck climbing, weaving, and speed change, and having a specified compacted course thickness greater than 30 millimeters, shall be compacted to a specified level of relative density. The specified level of relative density shall be a Composite Pay Factor (CPF) of not less than 1.00 when evaluated in accordance with Section 1-06.2(1), using a minimum of 91.0 percent of the reference maximum density as determined by AASHTO T 209. The reference maximum density shall be determined as the moving average of the most recent five determinations for the lot of asphalt concrete being placed. The specified level of density attained will be determined by the statistical evaluation of five nuclear density gauge tests taken in accordance with WSDOT Test Method 715 on the day the mix

is placed (after completion of the finish rolling) at locations determined by the stratified random sampling procedure conforming to WSDOT Test Method 716 within each density lot. The quantity represented by each density lot will be no greater than a single day's production or approximately 400 tonnes, whichever is less. The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed in the field by 7:00 a.m. the morning of the next workday after testing, or for nighttime work within four hours after the beginning of the next paving shift. Acceptance of pavement compaction will be based on the statistical evaluation and CPF so determined.

For compaction lots falling below a 1.00 pay factor and thus subject to price reduction or rejection, cores may be used as an alternate to the nuclear density gauge tests. When cores are taken by the Contracting Agency at the request of the Contractor, they shall be requested by noon of the next workday after paving. The cost for the coring expenses when the core results indicate the specified level of relative density within a lot has not been achieved, will be deducted from any monies due or that may become due the Contractor under the contract at the rate of $75 per core.

At the start of paving, the Contractor must demonstrate to the Engineer that the mix is compactible by constructing compaction test section(s). Test section(s) shall be constructed using the compaction train and a variety of rolling patterns that the Contractor expects to use in the paving operation. A test section will be considered to have established compatibility, based on the results of three density determinations, when the average of the three tests exceeds 92 percent of Rice or when all three tests individually exceed 91 percent of Rice. This will require consideration of the presence of a correlation factor for the nuclear gauge and may require final resolution after the factor for the gauge is known. A minimum 1.00 compaction pay factor shall be used until a gauge correlation factor is known, and until the mix is considered compactible. When construction of the test section(s) has demonstrated that the mix is not compactible, paving must stop. To resume paving, all factors contributing to compaction shall be analyzed and Engineer approved changes made, which may require a new mix design. When paving is resumed, the Contractor must again, as previously defined, demonstrate that the mix is compactible. If the Contractor does not construct test section(s), the mix is considered compactible and all mix placed will be evaluated according to Section 5-04.3(10)B.

Asphalt Concrete Classes A, B, E, F, and G constructed under conditions other than listed above shall be compacted on the basis of a test point evaluation of the compaction train. The test point evaluation shall be performed in accordance with instructions from the Engineer. The number of passes with an approved compaction train, required to attain the maximum test point density, shall be used on all subsequent paving.

Asphalt Concrete Class D and preleveling mix shall be compacted to the satisfaction of the Engineer.

In addition to the randomly selected locations for tests of the density, the Engineer may also isolate from a normal lot any area that is suspected of being defective in relative density. Such isolated material will not include an original sample location. A minimum of 5 randomly located density tests will be taken. The isolated area will then be evaluated for price adjustment in accordance with the statistical acceptance section, considering it as a separate lot.

5-04.3(11) Joints

The placing of the top or wearing course shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued for such length of time as to permit the mixture to become chilled. When the work is resumed, the previously compacted mixture shall be cut back to produce a slightly beveled edge for the full thickness of the course.

Where a transverse joint is being made in the wearing course, strips of heavy wrapping paper shall be used. The wrapping paper shall be removed and the joint trimmed to a slightly beveled edge for the full thickness of the course prior to resumption of paving.

The material which is cut away shall be wasted and new mix shall be laid against the fresh cut. Rollers or tamping irons shall be used to seal the joint.

Where the asphalt concrete is placed against a concrete or stone curb or gutter, against a cold pavement joint, or any metal surface, a thin paint coat of emulsified asphalt shall be applied in advance. The application shall be thin and uniform, care being exercised to avoid accumulation of asphalt in depressions.

The longitudinal joint in any one layer shall be offset from the layer immediately below by not more than 150 millimeters nor less than 50 millimeters. All longitudinal joints constructed in the top layer shall be at a lane line or edge line of the traveled way. However, on one-lane ramps a longitudinal joint may be constructed at the center of the traffic lane, subject to approval by the Engineer, if:

1. The ramp must remain open to traffic, or
2. The ramp is closed to traffic and a hot-lap joint is constructed.

If a hot-lap joint is allowed, two paving machines shall be used; a minimum compacted density in accordance with Section 5-04.3(10)B shall be achieved throughout the traffic lane; and construction equipment shall not impact any uncompacted mix.

When asphalt concrete pavement is placed adjacent to cement concrete pavement, the Contractor shall construct longitudinal joints between the asphalt concrete pavement and the cement concrete pavement. The joint shall be sawed to the dimensions shown on the Standard Plan and filled with material meeting the requirements of Section 9-04.2.

5-04.3(12) Samples

The Engineer reserves the right to have samples cut or cored from the completed pavement or the individual courses. Additionally, the Engineer may take samples of the uncompressed asphalt concrete mixtures as well as all materials incorporated in the work. Where samples have been taken from the uncompressed asphalt concrete, new material shall be placed and compacted to conform with the surrounding area at no additional expense to the Contracting Agency.

5-04.3(13) Surface Smoothness

The completed surface of all courses shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The completed surface of the wearing course shall not vary more than 3 millimeters from the lower edge of a 3-meter straightedge placed on the surface parallel to the centerline. The transverse slope of the completed surface of the wearing course shall vary not more than 6 millimeters in 3 meters from the rate of transverse slope shown in the Plans.

When deviations in excess of the above tolerances are found, the pavement surface shall be corrected by the addition of asphalt concrete mixture of an appropriate class to low places or the removal of material from high places by grinding with an approved grinding

machine or by removal and replacement of the wearing course of asphalt concrete. Correction of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances.

All areas in which the surface of the completed pavement deviates more than twice the allowable tolerances described above shall be removed and replaced to the satisfaction of the Engineer.

However, if deviations are found which exceed the allowable tolerances but are not in excess of twice the allowable tolerances described above, and, in the opinion of the Engineer, correction by means of any of the methods specified above will not produce satisfactory results as to smoothness and serviceability, the Engineer may accept the completed pavement and shall deduct from monies due or that may become due to the Contractor the sum of $500.00 for each and every section of single traffic lane 30 meters in length in which any deviations as described above are found. Under the circumstances described above, the decision whether to accept the completed pavement or to require corrections as described above shall be vested entirely in the Engineer.

All costs involved in making the corrections of defects described above shall be borne by the Contractor and no compensation will be made for this work.

When Portland cement concrete pavement is placed on asphalt concrete pavement, the surface tolerance of the asphalt concrete pavement shall be such that no elevation lies above the plan grade minus the specified plan depth of Portland cement concrete pavement. Prior to placing the Portland cement concrete pavement, any such irregularities shall be brought to the required tolerance by grinding or other means approved by the Engineer, at no expense to the Contracting Agency.

When utility appurtenances such as manhole covers and valve boxes are located in the traveled way, the roadway shall be paved before the utility appurtenances are adjusted to the finished grade.

5-04.3(14) Planing Bituminous Pavement

The planing shall be performed with a milling machine of a type that has operated successfully on work comparable with that to be done under the contract and shall be approved by the Engineer prior to use.

The surface of existing pavements or the top surface of subsurface courses shall be planed to remove irregularities and to produce a smooth surface.

Planing shall be performed in a manner such that the underlying pavement is not torn, broken, or otherwise injured by the planing operation. The surface of the underlying pavement shall be slightly grooved or roughened sufficiently to ensure a bond when overlaid.

The Contractor shall keep the planings and remove them from the project, or stockpile the planings on Contracting Agency Property, if a site is shown in the Plans, for future use by the Contracting Agency. If the Planings are not to be stockpiled for the Contracting Agency's use, the Contractor may utilize the planings in the asphalt concrete pavement as specified in Section 5-04.2. All other debris resulting from the planing operations shall be disposed of by the Contractor to the satisfaction of the Engineer. Unless otherwise provided, the Contractor shall provide a waste site for the disposal of these materials.

For mainline planing operations, the equipment shall have automatic controls, with sensors for either or both sides of the equipment, capable of sensing the proper grade from an outside reference line, or multi-footed ski-like arrangement. The automatic controls

shall also be capable of maintaining the desired transverse slope. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.

5-04.3(15) Asphalt Concrete Approach

Asphalt approaches shall be constructed at the locations shown in the Plans or as directed by the Engineer in accordance with this section.

5-04.3(16) Weather Limitations

Asphalt concrete pavement for wearing course shall not be placed on any traveled way after October 15 without written approval from the Regional Administrator.

Asphalt for prime coat shall not be applied when the ground temperature is lower than 10°C, without written permission of the Engineer.

Asphalt concrete Class D shall not be placed when the air temperature is less than 16°C.

Asphalt concrete shall not be placed on any wet surface, or when the average surface temperatures are less than those specified in the following table, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

	Surface Temperature Limitations	
Compacted Thickness (Millimeters)	**Surface Course**	**Sub-Surface Courses**
Less than 30	13°C	13°C
30 to 60	7°C	2°C
61 to 105	2°C	2°C
More than 105	DNA	-4°C*

*Only on dry subgrade, not frozen and when air temperature is rising.

5-04.3(17) Paving Under Traffic

When the roadway being paved is open to traffic, the following requirements shall apply:

The Contractor shall keep on-ramps and off-ramps open to traffic at all times except when paving the ramp or paving across the ramp. During such time, the ramp may be closed for the minimum time required to place and compact the mixture provided there is advance warning of the ramp closure. In hot weather, the Engineer may require the application of water to the pavement to accelerate the finish rolling of the pavement and to shorten the time required before reopening to traffic.

Before closing a ramp, advance warning signs shall be placed and the detour or alternate route signed. Ramps shall not be closed on consecutive interchanges at the same time.

During paving operations, temporary pavement markings shall be maintained throughout the project. Temporary pavement markings shall be installed on the roadway that was paved that day. Temporary pavement markings shall be in accordance with Section 8-23.

All costs in connection with performing the work in accordance with these requirements, except the cost of temporary pavement markings, shall be included in the unit contract prices for the various bid items involved in the contract.

5-04.3(18) Change in Grade of Asphalt

If the Engineer orders a change in grade of paving asphalt, any additional compensation will be limited to the actual additional cost of the asphalt based on invoices from the supplier. If the cost of the substituted paving asphalt is lower, the difference in the cost and that of the original material specified, based on invoices from the supplier, shall be deducted from monies due the Contractor.

5-04.3(19) Sealing of Driving Surfaces

Any wearing course or other pavement course to be used for the driving surface will be evaluated by the Engineer to determine whether a fog seal is required. When the results of nuclear or core density testing show that a seal is needed, or when the surface course is asphalt concrete Class D, the Contractor shall apply a fog seal of CSS-1 at the rate 0.25 to 0.45 (0.15 to 0.25 residual) liters per square meter. Unless otherwise approved by the Engineer, fog seal shall be applied prior to opening to traffic. Material used for fog seal will be measured and paid for as asphalt for tack coat.

5-04.3(20) Anti-Stripping Additive

When directed by the Engineer, an anti-stripping additive shall be added to the asphalt material in accordance with Section 9-02.4.

5-04.3(21) Paving Asphalt Revision

Should the amount of new paving asphalt and recycling agent, if any, required by the job mix formula for a lot of asphalt concrete produced with aggregate from a Contracting Agency provided source vary by more than plus or minus 0.3 percent from the amount shown in the Special Provisions, an adjustment in payment will be made. The adjustment in payment (plus or minus) will be based on the invoice cost to the Contractor FOB at the project site. A new contract item, Paving Asphalt Revision, will be established for material varying from the Special Provision, Asphalt Content, by more than plus or minus 0.3 percent. No adjustment will be made when the Contractor elects not to use a Contracting Agency provided source, or when no source is made available by the Contracting Agency.

The new paving asphalt and recycling agent revision will be measured by the tonne with the quantity determined from the stated value, the job mix formula, and the asphalt concrete quantity in the lot in tonnes.

5-04.4 Measurement

Preparation of untreated roadway will be measured by the kilometer once along the centerline of the main line roadway. This measurement will include all main line roadways, ramps, auxiliary lanes, service roads, frontage roads, and any necessary shoulders. Measurement will be to the nearest 0.01 kilometer.

Asphalt for prime coat will be measured by the tonne in accordance with Section 1-09.

Prime coat aggregate will be measured by the cubic meter, truck measure, or by the tonne, whichever is designated in the proposal.

Asphalt for tack coat will be measured by the tonne, before dilution, in accordance with Section 1-09.

Asphalt concrete pavement, asphalt concrete approach, asphalt concrete for pavement repair, and asphalt concrete for preleveling will be measured by the tonne with no deduction being made for the mass of liquid asphalt, blending sand, mineral filler, or any other component of the mixture.

Paving asphalt will be measured by the tonne with the quantity determined from production data. The Contracting Agency reserves the right to make random checks of the gross and tare masses of the transport equipment at the time of delivery as well as measuring the asphalt volume in the storage tank prior to and after the deposit from the transport vehicle.

On continuous mix or rotary drum plants, the asphalt may be measured by deposits and withdrawals from storage tanks located explicitly for the project or from data obtained from the asphalt material feed as described in Section 5-04.3(1)D.

The decision as to method of measurement of asphalt will rest with the Contracting Agency. In no event will measurement be for more than the amount delivered to the job site as evidenced by the Notice of Asphalt Shipment.

Blending sand will be measured by the cubic meter in trucks at the plant.

Water will be measured and paid by the cubic meter as provided in Section 2-07.

Planing bituminous pavement will be measured by the square meter.

Soil residual herbicide will be measured by the kilometer for the stated width to the nearest .01 kilometer or by the square meter, whichever is designated in the proposal.

Longitudinal joint seals between the asphalt concrete pavement and cement concrete pavement will be measured by the meter along the line and slope of the completed joint seal.

Pavement repair excavation will be measured by the square meter in place prior to excavation.

5-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Preparation of Untreated Roadway", per kilometer.

The unit contract price per kilometer for "Preparation Of Untreated Roadway" shall be full pay for all work described under Section 5-04.3(5)B, with the exception, however, that all costs involved in patching the roadway prior to placement of asphalt concrete shall be included in the unit contract price per tonne for "Asphalt Conc. Pavement Cl. ____" which was used for patching. If the proposal does not include a bid item for "Preparation of Untreated Roadway", the roadway shall be prepared as specified, but the work shall be included in the contract prices of the other items of work.

"Asphalt (grade)", per tonne.

"Prime Coat Agg.", per cubic meter, or per tonne.

The unit contract price per cubic meter or per tonne for "Prime Coat Agg." shall be full pay for furnishing, loading, and hauling aggregate to the place of deposit and spreading the aggregate in the quantities required by the Engineer.

"Asphalt for Tack Coat", per tonne.

The unit contract price per tonne for "Asphalt for Tack Coat" shall be full pay for all costs of material, labor, tools, and equipment necessary for the application of the tack coat as specified. If there is no bid item and a tack coat is required, it shall be applied and the work shall be included in the unit contract prices of the other items of work.

"Asphalt Conc. Pavement Cl. ____", per tonne.

"Asphalt Conc. Approach Cl. ____", per tonne.

"Asphalt Conc. for Preleveling Cl. ____", per tonne.

The unit contract price per tonne for "Asphalt Conc. Pavement Cl. ____", "Asphalt Conc. Approach Cl. ____", and "Asphalt Conc. for Preleveling Cl. ____" shall be full pay for construction of each class of asphalt concrete pavement and approach, including the preparation of any existing Portland cement concrete, brick or bituminous surface, or pavement base.

If the Contractor is required to furnish the aggregates, all costs of furnishing, hauling and processing aggregates and blending sand into the complete mix shall be included in the unit contract price per tonne for asphalt concrete pavement of the class specified, except that blending sand, when set up as a bid item, will be paid for in the manner described below. At the discretion of the Engineer, the Contractor may be required to include mineral filler in the mix.

If any of the aggregates are furnished in stockpile by the Contracting Agency, the cost of hauling and incorporating those aggregates in the mix, and all costs of furnishing, hauling, and incorporating the necessary blending sand and any additional aggregates into the complete mix shall be included in the unit contract price per tonne for asphalt concrete pavement of the class specified, except that when blending sand is set up as a bid item, it will be paid for in the manner described below. At the discretion of the Engineer, the Contractor may be required to include mineral filler in the mix.

"Asphalt Conc. for Pavement Repair", per tonne.

All costs for tack coat shall be included in the unit contract price for "Asphalt Conc. for Pavement Repair".

"Pavement Repair Excavation Incl. Haul", per square meter.

"Blending Sand", per cubic meter.

If there is a bid item for blending sand and the Contractor elects to provide aggregates from a source other than that provided by the Contracting Agency, and if it becomes necessary, in the opinion of the Engineer, to use blending sand for proper grading of the aggregates, the Contractor shall furnish and incorporate sufficient quantities of blending sand to meet the requirements as determined by the Engineer. The pay quantity will be the amount actually used, but not exceeding the quantity set up in the contract. If there is no bid item for blending sand, whatever amount of blending sand as may be needed to meet the requirements as determined by the Engineer, shall be furnished by the Contractor at no expense to the Contracting Agency.

"Mineral Filler", by force account.

"Mineral Filler", if required, will be paid for by force account as specified in Section 1-09.6. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Planing Bituminous Pavement", per square meter.

"Anti-Stripping Additive", by force account.

"Anti-Stripping Additive" will be paid for in accordance with Section 1-09.6 except that no overhead, profit or other costs shall be allowed. Payment shall be made only for the invoice cost of the additive. The quantity of asphalt material shall not be reduced by the quantity of anti-stripping additive used. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Crack Sealing", by force account.

"Crack Sealing" will be paid for by force account as specified in Section 1-09.6. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Soil Residual Herbicide ____ m Wide," per kilometer.

"Soil Residual Herbicide", per square meter.

"Longitudinal Joint Seal", per meter.

"Job Mix Compliance Price Adjustment," by calculation.

Job Mix Compliance Price Adjustment" will be calculated and paid for as described in Section 5-04.5(1)A.

"Compaction Price Adjustment," by calculation.

"Compaction Price Adjustment" will be calculated and paid for as described in Section 5-04.5(1)B.

5-04.5(1) Quality Assurance Price Adjustments

All asphalt concrete pavement will be subject to price adjustments for Quality of AC Mix and Quality of AC Compaction based on the Acceptance Plans in effect for each class of ACP within the contract. For the purpose of providing a common proposal for all bidders, the Contracting Agency has estimated a calculated amount for all price adjustment items and has entered these amounts in the proposal to become a part of the total bid by the Contractor. Conditions (1) and (2) of the first paragraph of Section 1-04.6 do not apply to these items, and any impact due to an increase or decrease from plan quantities for these items will be the sole risk of the Contractor.

5-04.5(1)A Price Adjustments for Quality of AC Mix

Statistical analysis of quality of gradation and asphalt content will be determined based on Section 1-06.2 using the following price adjustment factors:

Table of Price Adjustment Factors

Constituent	Factor "f"
All aggregate passing 25 mm, 19 mm, 16 mm, 12.5 mm, and 9.5 mm sieves	2
All aggregate passing 6.3 mm sieve	6
All aggregate passing 2 mm sieve	10
All aggregate passing 0.425 mm sieve	6
All aggregate passing 0.075 mm sieve	20
Asphalt cement	52

Factors for Open Graded Mix

Constituent	Factor "f"
All aggregate passing 12.5 mm sieve	10
All aggregate passing 9.5 mm sieve	15
All aggregate passing 4.75 mm sieve	40
All aggregate passing 2.36 mm sieve	15
All aggregate passing 0.075 mm sieve	20

Note: Open graded mix shall be evaluated for gradation only. The quality incentive multiplier for open-graded mix shall be 40 percent rather than 60.

If a constituent is not measured in accordance with these Specifications, its individual pay factor will be considered 1.00 in calculating the Composite Pay Factor (CPF).

1. Statistical Acceptance. For each lot of asphalt concrete pavement produced under Statistical Acceptance, a Job Mix Compliance Incentive Factor (JMCIF) will be determined. The JMCIF equals the difference between the CPF and unity with regard to sign multiplied by 60 percent. The Job Mix Compliance Price Adjustment will be calculated as the product of the JMCIF, the quantity of asphalt concrete in the lot in tonnes, and the unit contract price per tonne of mix.
2. Nonstatistical Acceptance. Each lot of asphalt concrete pavement produced under Nonstatistical Acceptance and having all constituents falling within the limits of the job mix formula shall be accepted at the unit contract price with no further statistical evaluation. When one or more constituents fall outside the job mix formula, the lot shall be evaluated to determine the appropriate CPF. When less than three sublots exist, backup samples of the existing sublots or samples from the street shall be tested to provide a minimum of three sets of results for evaluation.

   For each lot of asphalt concrete pavement produced under Nonstatistical Acceptance when the calculated CPF is less than 1.00, a Nonconforming Mix Factor (NCMF) will be determined. The NCMF equals the difference between the CPF and unity with regard to sign multiplied by 60 percent. The Job Mix Compliance Price Adjustment will be calculated as the product of the NCMF, the quantity of asphalt concrete in the lot in tonnes, and the unit contract price per tonne of mix.

5-04.5(1)B Price Adjustments for Quality AC Compaction

For each compaction control lot, a Compaction Incentive Price Adjustment Factor (CIPAF) will be determined. The CIPAF equals the difference between the Composite Pay Factor and unity with regard to sign multiplied by 40 percent. The Compaction Compliance Price Adjustment will be calculated as the product of CIPAF, the quantity of asphalt concrete in the compaction control lot in tonnes, and the unit contract price per tonne of mix.

5-05 CEMENT CONCRETE PAVEMENT

5-05.1 Description

This work shall consist of constructing a pavement composed of Portland cement concrete on a prepared subgrade or base in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or established by the Engineer.

5-05.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Fine Aggregate	9-03
Coarse Aggregate	9-03
Joint Filler	9-04.1
Joint Sealants	9-04.2
Reinforcing Steel	9-07
Dowel Bars	9-07.5
Tie Bars	9-07.6
Curing Materials and Admixtures	9-23
Water	9-25
Epoxy Resins	9-26

5-05.3 Construction Requirements

5-05.3(1) Concrete Mix Design for Paving

The Contractor shall provide a concrete mix design for each design of concrete specified in the contract. The Contractor shall use ACI 211.1 as a guide to determine proportions. Concrete strength, placability, and workability shall be the responsibility of the Contractor. Following approval of the Contractor's proposal, all other requirements of Section 5-05 shall apply.

1. Materials. Materials shall conform to Section 5-05.2. Fine aggregate shall conform to Section 9-03.1(2), Class 1. Coarse aggregate shall conform to Section 9-03.1(4) AASHTO grading No. 467 or an alternate gradation which has a minimum of 5 percent retained on the 37.5 millimeter sieve. Fly ash, if used, shall conform to Section 9-23.9 and shall be limited to Class F with a maximum CaO content of 15 percent by mass. The fly ash shall be limited to 25 percent by mass, of the total cementitious material. As an alternative to the use of fly ash and cement as separate components, a blended hydraulic cement may be used. Blended hydraulic cement shall conform to ASTM C 595 Type IP.

   In making calculations relative to cement factor or allowable water/cement ratio, the total cementitious material shall be taken as the mass of Portland cement plus the mass of fly ash. The minimum cementitious material for any mix design shall be 335 kilograms per cubic meter.
2. Submittals. The Contractor's submittal shall include the mix proportions per cubic meter and the proposed sources for all ingredients including the power plant that generated the fly ash. The mix shall be capable of providing a minimum flexural strength of 4.5 megapascals at 14 days. Evaluation of strength shall be based on statistically analyzed results of 5 beam specimens and demonstrate a quality level of not less than 80 percent analyzed in accordance with Section

1-06.2(2)D. In addition the Contractor shall fabricate, cure, and test 5 sets of cylinders using the same mix design as used in fabrication of the beams. Compressive strengthdata (for both 14 and 28 day strength) shall be submitted to the Engineer for use in determination of a conversion factor of flexural strength to compressive strength, which may be used by the Engineer for strength acceptance testing.

Mix designs submitted by the Contractor shall provide a unique identification for each proposal and shall include test data confirming that concrete made in accordance with the proposed design will meet the requirements of these Specifications. Test data shall be from an independent testing lab or from a commercial concrete producer's lab. If the test data is developed at a producer's lab, the Engineer or a representative may witness all testing.

3. Mix Design Modifications. The Contractor may initiate minor adjustments to the approved mix proportions. A plus or minus 90-kilogram variation in both the coarse and fine aggregate target mass will be allowed from the approved Contractor provided mix design mass as a modification without resubmittal.

   Utilizing admixtures to accelerate the set or to increase workability will be permitted only when approved by the Engineer

   The Contractor shall notify the Engineer in writing of any proposed modification. A new mix design will designate a new lot.

5-05.3(2) Consistency

The materials shall be mixed with sufficient water to produce a stiff concrete which will hold its shape when deposited upon the subgrade. Concrete placed during wet weather must be mixed with sufficient water to produce a very stiff mixture. The consistency shall be such that separation of the mortar from the coarse aggregate will not occur in handling.

The water/cementitious material ratio, by mass, shall not exceed 0.44. When slip form paving equipment is used, the Contractor shall further control concrete consistency to ensure that edge slump conforms to the requirements of Section 5-05.3(11).

5-05.3(3) Equipment

Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

1. Batching Plant and Equipment
   a. General. The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. The batching plant shall be equipped with a suitable nonresettable batch counter which will correctly indicate the number of batches proportioned.
   b. Bins and hoppers. Bins with adequate separate compartments for fine aggregate and for each size of the coarse aggregate shall be provided in the batching plant.

2. Mixers
   a. General. Concrete may be mixed at a batching plant or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
   b. Batching plant. Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period.

      Mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum shall be repaired or replaced when they are worn down 19 millimeters or more. The Contractor shall have available at the jobsite a copy of the manufacturer's design, showing dimensions and arrangements of the blades in reference to original height and depth, or provide permanent marks on blades to show points of 19 millimeters wear from new conditions. Drilled holes 6 millimeters in diameter near each end and at midpoint of each blade are recommended.
   c. Truck mixers and truck agitators. Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling plant-mixed concrete, shall conform to the requirements of Section 6-02.3(4)A.
   d. Nonagitator trucks. Bodies of nonagitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection. Plant-mixed concrete may be transported in nonagitated vehicles provided that the concrete is delivered to the site of the work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed.
3. Finishing Equipment. The standard method of constructing concrete pavement on state highways shall be with approved slip-form paving equipment designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so a dense and homogeneous pavement is achieved with a minimum of hand finishing. On other roads and on WSDOT projects requiring less than 500 square meters of cement concrete pavement or requiring individual placement areas of less than 500 square meters, irregular areas, and at locations inaccessible to slip-form paving equipment, cement concrete pavement may be placed with approved placement and finishing equipment utilizing stationary side forms. Hand screeding and float finishing of cement concrete pavement may only be utilized on small irregular areas as allowed by the Engineer.
4. Joint Sawing Equipment. The Contractor shall provide approved power driven concrete saws for sawing joints, adequate in number of units and power to complete the sawing at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during

concrete placement. Sawing equipment shall be available immediately and continuously upon call by the Engineer on a 24 hour basis, including Saturdays, Sundays and holidays.

5. Smoothness Testing Equipment. The Contractor shall provide a California-type computerized profilograph, complete with recorder, for determining the profile index of the pavement according to WSDOT Test Method No. 807. The profilograph shall be on the project, calibrated, in good working condition, and ready for operation before construction of any concrete pavement begins. The operator shall be competent and experienced in operation of the equipment.

5-05.3(4) Measuring, and Batching Materials

The batch plant site, layout, equipment, and provisions for transporting material shall ensure a continuous supply of material to the work.

1. Measuring Materials
   a. Aggregates. The fine aggregate and each size of coarse aggregate shall be measured by weighing, the mass for the particular aggregates used being proportional to their respective bulk specific gravities. The weighing of each size of material shall be a separate and distinct operation.

      Corrections shall be made for variations in mass of materials due to the moisture content.

      The equipment for weighing aggregates shall conform to the requirements of Section 1-09.2.
   b. Cement. Cement shall be weighed on scales meeting the requirements of Section 1-09.2. Adequate provision shall be made to prevent loss of cement between the batch box and the mixer.
   c. Water. Water may be measured either by volume or by mass. The accuracy of measuring the water shall be within a range of error of not over 1 percent.
2. Batching Materials. On all projects requiring more than 2000 cubic meters of Portland cement concrete for paving, the batching plant shall be equipped to proportion aggregates and cement by mass by means of automatic and interlocked proportioning devices of approved type.

5-05.3(4)A Acceptance of Portland Cement Concrete Pavement

Acceptance of Portland cement concrete pavement shall be based on statistical evaluation for air content and strength per section 1-06.2(2). The point of acceptance will be per Western Alliance for Quality Transportation Construction (WAQTC) TM 2 or at the point of discharge when a pump is used.

Acceptance of Concrete. The concrete producer shall provide a certificate of compliance for each truckload of concrete in accordance with Section 6-02.3(5)B.

For the purpose of acceptance sampling and testing, a lot is defined as the total quantity of material to be used that was produced from the same operation. All of the test results obtained from the same material shall be evaluated collectively and shall constitute a lot. The quantity represented by each sample will constitute a sublot. Sampling and testing for statistical acceptance shall be performed on a random basis at the frequency of one sample per sublot. Sublot size shall be determined to the nearest 10 cubic meters to provide not less than three uniform sized sublots with a maximum sublot size of 400 cubic meters.

The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed within 2 working days after testing. The Engineer will also provide the Composite Pay Factor (CPF) of the completed sublots after three have been tested.

Acceptance testing for compliance of air content and 28 day compressive strength shall be conducted from samples prepared according to WAQTC TM 2. Air content shall be determined by conducting WAQTC FOP for AASHTO T 152. If the contractor fails to provide the Aggregate Correction Factor per WAQTC FOP for AASHTO T 152 with the mix design, one will not be applied. Compressive Strength shall be determined by conducting AASHTO T 22.

The quality limits as defined in section 1-06.2(2)D shall be as follows. The lower quality limit for Air Content shall be 3.5 percent. The upper quality limit for Air Content shall be 6.5 percent. The lower quality limit for compressive strength shall be 7.0 Mpa less than that established in the mix design as the arithmetic mean of the five sets of 28 day compressive strength cylinders, or 20 Mpa, whichever is higher. These compressive strength cylinders are to be cast at the same time as the flexural beams that were used to pre-qualify the mix design under section 5-05.3(1). There is no upper quality limit for 28 day compressive strength.

The price adjustment factor defined in section 1-06.2(2)D shall be six (6) for compressive strength and four (4) for air content.

If either the air content or compressive strength is not measured in accordance with this section its individual pay factor will be considered to be 1.00 in calculating the Composite Pay Factor.

Rejection of Concrete:

1. Rejection by the Contractor. The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. Any such new material will be sampled, tested and evaluated for acceptance.
2. Rejection without Testing. The Engineer may reject any load that appears defective prior to placement. Material rejected before placement shall not be incorporated into the pavement. No payment will be made for the rejected materials unless the Contractor requests that the rejected material be tested. If the Contractor elects to have the rejected materials tested, a minimum of three representative samples will be obtained and tested.

Payment for rejected material will be based on conformance with the statistical acceptance specification. If the CPF for the rejected material is less than 0.75, no payment will be made for the rejected material and in addition, the cost of sampling and testing, at the rate of $250.00 per test, shall be borne by the Contractor. If the CPF for the rejected material is greater than 0.75, the mix will be compensated at the new CPF and the cost of the sampling and testing will borne by the Contracting Agency.

The maximum calculated Composite Pay Factor shall be 1.00.

5-05.3(5) Mixing Concrete

The concrete may be mixed in a batching plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with the requirements of Section 6-02.3(4), 6-02.3(4)A, and 6-02.3(4)B.

When mixed in a batching plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at no expense to the Contracting Agency. The volume of concrete mixed per batch shall not exceed the mixer's rated capacity as shown on the manufacturer's standard rating plate on the mixer.

Each concrete mixing machine shall be equipped with a device for counting automatically the number of batches mixed during the day's operation.

Retempering concrete by adding water or by other means will not be permitted.

5-05.3(5)A Limitations of Mixing

Concrete shall not be mixed, placed, or finished when the natural light is inadequate, as determined by the Engineer, unless an adequate and approved artificial lighting system is operated.

Mixing and placing concrete shall be discontinued when a descending air temperature in the shade away from artificial heat reaches 4°C and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 2°C unless authorized in writing by the Engineer.

When mixing and placing is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might injure the materials. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 10°C and not more than 32°C at the time of discharge into the hauling conveyance. No concrete shall be mixed with frozen aggregates.

5-05.3(6) Subgrade

The subgrade shall be constructed in accordance with Section 2-06.

The subgrade shall be prepared and compacted a sufficient distance beyond each edge of the area which is to receive concrete pavement in order to accommodate the slip-form equipment. Concrete shall not be placed on a frozen subgrade nor during heavy rainfall.

The subgrade shall be moist before the concrete is placed.

When the subgrade is an asphalt treated base the surface shall be clean and free of any deleterious materials. When placing concrete on a treated base, the surface temperature shall not exceed 32°C. If water is used for cooling any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.

5-05.3(7) Placing, Spreading, and Compacting Concrete

5-05.3(7)A Slip-Form Construction

The concrete shall be distributed uniformly into final position by a self propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of pavement and/or a series of equally spaced longitudinal vibrating units. The space from the outer edge of the pavement to the outer longitudinal unit shall not exceed 230 millimeters. The spacing of internal units shall be uniform and not exceed 450 millimeters.

The term internal vibration means vibration by vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be not less than 7,500 cycles per minute, and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least 300 millimeters. The frequency of vibration or amplitude shall be varied proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. Referee testing of hardened concrete will be performed by cutting cores from the finished pavement after a minimum of 24 hours of curing. Density determination will be made based on the water content of the core as taken. AASHTO T 85 shall be used for the determination of core density. Reference cores will be taken at the minimum rate of one for each 400 cubic meters of pavement, or fraction thereof. These same cores will be used for thickness measurements as required by Section 5-05.5(1).

The average density of the cores shall be at least 97 percent of the original mix design density with no cores having a density of less than 96 percent of the original mix design density.

Failure to meet the above requirement will be considered as evidence that the minimum requirements for vibration are inadequate for the job conditions, and additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete as indicated by further referee testing shall conform to the above listed requirements. Primary units of pavement, as defined in Section 5-05.5(1), not meeting the prescribed minimum density shall be removed and replaced with satisfactory material. At the option of the Engineer, noncomplying material may be accepted at a reduced price.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

5-05.3(7)B Stationary Side Form Construction

Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable materials may be used.

Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such build-up is attached to the top of metal forms, the build-up shall be of metal.

Width of the base of all forms shall be equal to at least 80 percent of specified pavement thickness.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the mass of subgrading and paving equipment or from the pressure of concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing the concrete due to lack of forms.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the edge of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.

Immediately in advance of placing concrete and after all subgrade operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing concrete.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms are removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Concrete shall be spread, screeded, shaped, and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that completed pavement will conform to required cross section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.

Concrete for the full paving width shall be effectively consolidated by means of surface vibrators, in combination with internal vibrators, or by some other method of consolidation that produces equivalent results without segregation.

When vibrators are used to consolidate concrete, the rate of vibration shall be not less than 3,500 cycles per minute for surface vibrators and shall be not less than 7,000 cycles per minute for internal vibrators. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than 300 millimeters from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. Referee testing of hardened concrete and all of the requirements of Section 5-05.3(7)A related to density apply to pavement constructed with stationary side forms.

Existing pavement shall be protected as specified in Section 5-0.3(7)A.

5-05.3(8) Joints

Joints in cement concrete pavement will be designated as longitudinal and transverse contraction joints and longitudinal and transverse construction joints, and shall be constructed as shown in the Plans and in accordance with the following provisions:

All contraction joints shall be constructed at the locations, intervals, and depths shown in the Standard Plan. The faces of all joints shall be constructed perpendicular to the surface of the cement concrete pavement.

5-05.3(8)A Contraction Joints

All transverse and longitudinal contraction joints shall be formed with suitable power-driven concrete saws. The Contractor shall provide sufficient sawing equipment capable of completing the sawing to the required dimensions and at the required rate to control cracking. The Contractor shall provide adequate artificial lighting facilities for night sawing. Joints shall not vary from the specified or indicated line by more than 19 millimeters.

Commencement of sawing transverse contraction joints will be dependent upon the setting time of the concrete and shall be done at the earliest possible time following placement of the concrete without tearing or raveling the adjacent concrete excessively.

Longitudinal contraction joints shall be sawed as required to control cracking and as soon as practical after the initial control transverse contraction joints are completed.

Any damage to the curing material during the sawing operations shall be repaired immediately after the sawing is completed.

When cement concrete pavement is placed adjacent to existing cement concrete pavement, the vertical face of all existing working joints shall be covered with building paper or other suitable material.

5-05.3(8)B Sealing Sawed Contraction Joints

Sawed contraction joints shall be filled with a joint sealant filler conforming to the requirements of Section 9-04.2. Joints shall be thoroughly clean at the time of sealing and if the hot-poured type is used the joints shall be dry. Care shall be taken to avoid air pockets. The hot-poured compound shall be applied in two or more layers, if necessary. The cold-poured compound shall be applied under sufficient pressure to fill the groove from bottom to top and to a point approximately 6 millimeters below the surface of the concrete. The joint filled with cold-poured compound shall then be covered with a strip of nonabsorptive paper at least twice as wide as the joint and the paper shall be left in place.

5-05.3(8)C Construction Joints

When placing of concrete is discontinued for more than 45 minutes, a transverse construction joint shall be installed. Construction joints shall be as shown in the Standard Plan.

Transverse construction joints shall be constructed between cement concrete pavement and reinforced concrete bridge approach slabs.

All transverse and longitudinal construction joints, including the joint between new and existing pavement when widened, shall be sawed and sealed with joint filler conforming to the requirements of Sections 5-05.3(8)A and 9-04.2.

5-05.3(9) Vacant

5-05.3(10) Tie Bars and Dowel Bars

Epoxy-coated tie bars shall be placed at all longitudinal contraction and construction joints, in accordance with the requirements shown in the Standard Plan. In addition, tie bars shall be installed when concrete shoulders are placed as a separate operation or when widening existing pavement.

Epoxy-coated tie bars shall be placed at longitudinal construction joints between lanes in a manner that the individual bars are located at the required elevation and spaced as shown in the Standard Plan and in a manner that the vertical edge of the concrete is not deformed or otherwise damaged during placement of the bars.

Placement tolerances for tie bars shall be within 25 millimeters of the middle of the concrete slab, within 25 millimeters of being centered over the joint and placed parallel or perpendicular to centerline within 25 millimeters of the vertical and horizontal plane.

Epoxy coated dowel bars will be required for the construction joint at the end of paving operations each day and they shall be placed in accordance with the Standard Plan. When required by the contract, epoxy coated dowel bars shall be placed at each transverse contraction joint in accordance with the Standard Plans.

Placement tolerances for dowel bars shall be within 25 millimeters of the middle of the concrete slab, within 25 millimeters of being centered over the transverse joint and parallel to centerline within 12 millimeters of the vertical and the horizontal plane.

When new concrete pavement is to be placed against existing cement concrete pavement, epoxy-coated tie bars shall be drilled and grouted into the existing pavement with epoxy resin in accordance with the Standard Plan and specified tolerances for placement of tie bars. The Contractor may use any method for drilling the holes, provided the method selected does not damage the existing concrete. Any damage caused by the Contractor's operations shall be repaired by the Contractor at no cost to the Contracting Agency and the repair shall be to the satisfaction of the Engineer.

The tie bar holes shall be blown clean with compressed air before grouting. The bar shall be centered in the hole for the full length of embedment before grouting. The grout shall then be pumped into the hole around the bar in a manner that the back of the hole will be filled first. Blocking or shimming shall not impede the flow of the grout into the hole. Dams, if needed, shall be placed at the front of the holes to confine the grout. The dams shall permit the escape of air without leaking grout and shall not be removed until grout has cured in the hole.

5-05.3(11) Finishing

After the concrete has been given a preliminary finish by means of finishing devices incorporated in the slip-form paving equipment, the surface of the fresh concrete shall be checked by the Contractor with a straightedge device not less than 3 meters in length. High areas indicated by the straightedge device shall be removed by the hand-float method. Each successive check with the straightedge device shall lap the previous check path by at least one half of the length of the straightedge. The requirements of this paragraph may be waived if it is successfully demonstrated that other means will consistently produce a surface with a satisfactory profile index and meeting the 3-meter straightedge requirement specified in Section 5-05.3(12).

Any edge slump of the pavement, exclusive of specified edging, in excess of 6 millimeters shall be corrected before the concrete has hardened. If edge slump on any 300-millimeter or greater length of hardened concrete exceeds 25 millimeters, the concrete shall be repaired as provided in section 5-05.3(22).

The pavement shall be given a final finish surface by texturing with a comb perpendicular to the center line of the pavement. The comb shall produce striations approximately 3 millimeters to 5 millimeters in depth. Randomly space the striations from 12 millimeters to 32 millimeters. The comb shall be operated mechanically either singly or in gangs with several placed end to end. Finishing shall take place with the elements of the comb as nearly perpendicular to the concrete surface as is practical, to eliminate dragging the mortar. If the striation equipment has not been previously approved, a test section shall be constructed prior to approval of the equipment. If the pavement has a raised curb without a formed concrete gutter, the texturing shall end 0.6 meter from the curb line.

At the beginning and end of paving each day, the Contractor shall, with an approved stamp, indent the concrete surface near the right hand edge of the panel to indicate the date, month, and year of placement.

At approximate 150-meter intervals where designated by the Engineer the Contractor shall, with an approved stamp, indent the concrete surface near the right hand edge of the pavement with the stationing of the roadway.

5-05.3(12) Surface Smoothness

The pavement smoothness will be checked under supervision of the Engineer no later than 5:00 p.m. of the day following placement of concrete, with equipment furnished and operated by the Contractor. Smoothness of all pavement placed except shoulders, ramp tapers, and small or irregular areas as defined by Section 5-05.3(3) unless specified otherwise, will be measured with a recording profilograph, as specified in Section 5-05.3(3), parallel to centerline, from which the profile index will be determined in accordance with WSDOT Test Method 807.

For the purpose of qualifying the equipment and methods used by the Contractor, a daily profile index will be computed. For pavement placed in a 3.6-meter width or less, the daily profile index will be the average of two profiles made approximately 0.9 meter from and parallel to each edge of the pavement. If the pavement is placed in a width greater than 3.6 meters, the daily profile index will be computed as the average of profiles made approximately 0.9 meter from and parallel to each edge and at the approximate location of each planned longitudinal joint.

The daily profile index of the finished pavement thus determined will be 100 millimeters per kilometer, or less. Only equipment and methods that consistently produce a finished surface meeting this requirement shall be used. Should the daily profile index exceed the rate of 100 millimeters per kilometer, the paving operations shall be discontinued until other methods or equipment are provided by the Contractor. Such revised methods and equipment shall again be discontinued if they do not produce a finished surface having a daily profile index of 100 millimeters per kilometer, or less. Operations shall not be resumed until the Engineer approves further changes in methods and equipment as proposed by the Contractor.

All areas representing high points having deviations in excess of 7 millimeters as determined by procedures described in WSDOT Test Method 807, shall be reduced by abrasive methods until such deviations do not exceed 2.5 millimeters as determined by reruns of the profilograph. High areas of individual profiles shall be reduced by abrasive

means so that the profile index will not exceed 10 millimeters in any 0.1 kilometer section. All high areas in excess of 2.5 millimeters shall be reduced to 0.0 millimeters prior to reducing any high points of 2.5 millimeters or less. Low spots exceeding 6 millimeters shall be corrected in a manner approved by the Engineer.

When any of the daily profile indexes exceed 100 millimeters per kilometer, final acceptance of the pavement for smoothness parallel to the centerline will be based on profile indexes as measured with the profilograph, operating by the Contractor under the supervision of the Engineer, along a line parallel to the edge of pavement and each longitudinal joint and will not be averaged for acceptance purposes. The final acceptance profile indexes will be measured after all corrective work is complete and will demonstrate that all 0.1-kilometer sections on the project are within the 10-millimeter specification.

When cement concrete pavement abuts bridges, the finished pavement parallel to centerline within 5 meters of the abutting joint shall be uniform to a degree that no variations greater than 3 millimeters are present when tested with a 3-meter straightedge.

When paving small or irregular areas, as defined in Section 5-05.3(3), surface smoothness will be measured with a 3-meter straightedge no later than 5:00 p.m. of the day following the placing of the concrete. A 3-meter straightedge will be placed parallel to the centerline so as to bridge any depressions and touch all high spots. Should the surface vary more than 3 millimeters from the lower edge of the straightedge, the high portion shall be reduced by the Contractor to the 3 millimeters tolerance by abrasive means at no expense to the Contracting Agency. It is further provided that if reduction of high portions of the surface involves breaking, dislodging, or other disturbance of the aggregates, such cutting will not be permitted until the pavement has achieved its design age. If in the opinion of the Engineer irregularities cannot be satisfactorily removed by such methods, the Contractor shall remove and replace the pavement at no expense to the Contracting Agency.

Smoothness perpendicular to the centerline will be measured with a 3-meter straight edge. The transverse slope of the finished pavement shall be uniform to a degree such that no variations greater than 6 millimeters are present when tested with a 3-meter long straightedge laid in a direction perpendicular to the centerline. Any areas that are in excess of this specified tolerance shall be corrected by abrasive means.

5-05.3(13) Curing

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods the Contractor may elect.

5-05.3(13)A Curing Compound

Liquid membrane-forming concrete curing compound Type 2 meeting the requirements of Section 9-23.2 shall be applied to the entire area of the exposed surface of the concrete with an approved mechanical spray machine. The spray fog shall be protected from the wind with an adequate shield. It shall be applied uniformly at the rate of one liter to not more than 3.7 square meters.

The compound shall be applied with equipment of the pressure tank or pump type equipped with a feed tank agitator which ensures continuous agitation of the compound during spraying operations. The nozzle shall be of the two line type with sufficient air to properly atomize the compound.

The curing compound shall not be applied during or immediately after rainfall. If it becomes necessary to leave the pavement uncoated overnight, it shall be covered with polyethylene sheeting which shall remain in place until weather conditions are favorable for the application of the curing compound.

In the event that rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or in the event of damage to the film from any cause, the Contractor shall apply a new coat of curing compound in one or two applications to the affected area at the rate which, in the opinion of the Engineer, will result in a film of curing value equal to that specified in the original coat.

Before placing the curing compound in the spray tank, it shall be thoroughly agitated as recommended by the Manufacturer. The compound shall not be diluted by the addition of solvents nor be altered in any manner. If the compound has become chilled to the extent that it is too viscous for proper stirring or application or if portions of the vehicle have been precipitated from solution, it shall be heated to restore proper fluidity but it shall not be heated above 38°C. All curing compound shall have approval prior to placing in the spray tanks.

The curing compound shall be applied immediately after the concrete has been finished and after any bleed water that has collected on the surface has disappeared, or at a time designated by the Engineer. If hair checking develops in the pavement before finishing is completed, the Engineer may order the application of the curing compound at an earlier stage, in which event any concrete cut from the surface in finishing operations shall be removed entirely from the pavement. If additional mortar is then needed to fill torn areas, it shall be obtained ahead of the spraying operations. All areas cut by finishing tools subsequent to the application of the curing compound shall immediately be given new applications at the rate specified above.

The curing compound, after application, shall be protected by the Contractor from injury until the pavement has reached a minimum compressive strength of 17 megapascals. All traffic, either by foot or otherwise, shall be considered as injurious to the film of the applied compound.

The Contractor shall provide on the job a sufficient quantity of white polyethylene sheeting to cover all the pavement laid in three hours of maximum operation. This sheeting shall be reserved exclusively for the protection of the pavement in case of rain or breakdown of the spray equipment used for applying the curing compound. The protective sheeting shall be placed over the pavement when ordered, and in the manner specified by the Engineer.

Areas from which it is impossible to exclude traffic shall be protected by a covering of sand or earth not less than 0.3 meter in thickness or by other suitable and effective means. The protective covering shall be placed no earlier than 24 hours after application of the compound.

All liquid membrane-forming curing compounds shall be removed from the Portland cement concrete pavement to which traffic delineators are to be bonded. Curing compound removal shall not be started until the pavement has attained sufficient flexural strength for traffic to be allowed on it. The Contractor shall submit a proposed removal method to the Engineer and shall not begin the removal process until the Engineer has approved the removal method.

The Contractor shall assume all liabilities for and protect the Contracting Agency from any damages or claims arising from the use of materials or processes described herein.

5-05.3(13)B White Polyethylene Sheeting

The sheeting shall be placed over the pavement immediately after finishing operations are completed, or at a time designated by the Engineer.

The sheeting shall be laid so that individual sheets overlap at least 0.6 meter, and the lapped areas shall be held in close contact with the pavement by weighting with earth or boards to prevent movement by the wind. The sheeting shall extend downward to cover the edges of the pavement and shall be secured to the subgrade with a continuous bank of earth or surfacing material. Any holes occurring in the sheeting shall be patched immediately to the satisfaction of the Engineer. The sheeting shall be maintained against injury and remain in place until the pavement has reached a minimum compressive strength of 17 megapascals.

5-05.3(13)C Wet Curing

Wet curing shall be accomplished by applying a continuous fog or mist spray to the entire pavement surface until it has reached a minimum compressive strength of 17 megapascals. If water runoff is not a concern, continuous sprinkling is acceptable. Sprinkling shall not begin until the concrete has achieved initial set as determined by AASHTO T 197 or other approved method.

5-05.3(14) Cold Weather Work

When the air temperature is expected to reach the freezing point during the day or night and the pavement has not reached 50 percent of its design strength or 17 megapascals, which ever is greater, the concrete shall be protected from freezing. The Contractor shall, at no expense to the Contracting Agency, provide a sufficient supply of straw, hay, grass, earth, blankets, or other suitable blanketing material and spread it over the pavement to a sufficient depth to prevent freezing of the concrete. The Contractor shall be responsible for the quality and strength of the concrete thus cured. Any concrete injured by frost action or freezing shall be removed and replaced at the Contractor's expense in accordance with these Specifications.

5-05.3(15) Concrete Pavement Construction in Adjacent Lanes

Unless otherwise shown in the Plans or in the Special Provisions, the pavement shall be constructed in multiple lanes; that is, two or more adjacent lanes paved in a single operation. Longitudinal contraction joints shall be used between adjacent lanes that are paved concurrently, and construction joints shall be used when lanes are paved separately. Tie bars shall be installed during initial lane construction.

The Contractor shall replace, at no expense to the Contracting Agency, any panels on the new pavement that are cracked or broken as a result of the Contractor's operations.

5-05.3(16) Protection of Pavement

The Contractor shall protect the pavement and its appurtenances from any damage. Protection shall include personnel to direct traffic and the erection and maintenance of warning signs, lights, barricades, temporary take-down bridges across the pavement with adequate approaches, and whatever other means may be necessary to accommodate local traffic and to protect the pavement during the curing period or until opened to traffic as determined by the Engineer.

The operation of construction equipment on the new pavement will not be allowed until the pavement has developed a compressive strength of 17 megapascals as determined from cylinders, made at the time of placement, cured under comparable conditions, and

tested in accordance with AASHTO T 22. Exceptions would be one track from a slip form paving machine when paving adjacent lanes or light vehicles required for sawing operations or taking cores.

Placement of shoulder material may commence when the pavement has developed a compressive strength of 12.5 megapascals as determined from cylinders made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22 as long as construction equipment is not operated on the new pavement.

A continuous barrier of the design shown in the Plans shall be constructed and maintained along the edge of the pavement being constructed and adjacent to the portion of the roadway used for traffic. The barriers shall be left in place until the new pavement is ready to be opened to traffic and shall then be removed by the Contractor.

Any damage to the pavement occurring prior to final acceptance shall be replaced or repaired in accordance with Section 5-05.3(22).

5-05.3(17) Opening to Traffic

The pavement may be opened to traffic when the concrete has developed a compressive strength of 17 megapascals as determined from cylinders, made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22.

Fabrication, curing, and testing of cylinders to measure early strength shall be the responsibility of the Contractor. The Contractor shall obtain the services of an independent laboratory to perform these activities and these laboratories shall be approved by the Engineer. At the Contractor's option, the time for opening pavement may be determined through the use of the maturity test in accordance with ASTM C 1074. The Contractor shall develop the maturity-strength relationship and provide maturity curves along with supporting data for approval by the Engineer. The Contractor shall furnish all equipment, including thermal or maturity meter, thermocouples, wire, and qualified personnel to monitor maturity and provide information to the Engineer. Field procedures to monitor maturity shall be submitted to the Engineer for approval prior to use. The pavement shall not be opened to traffic until the maturity-strength relationship shows the pavement has a compressive strength of 17 megapascals and approved by the Engineer.

The pavement shall be cleaned prior to opening to traffic.

All costs associated with early-strength cylinders shall be at the Contractor's expense.

5-05.3(18) Cement Concrete Approach

Concrete approaches shall be constructed at the locations shown in the Plans or as designated by the Engineer and in accordance with the contract documents.

Approach concrete can be standard portland cement concrete pavement or Class 28 conforming to the requirements of Section 6-02. Approach concrete may be placed, compacted, and finished using hand methods. The tools required for these operations shall be approved by the Engineer.

Curing of approach concrete shall be in accordance with Section 5-05.3(13).

Concrete approaches may be opened to traffic in accordance with Section 5-05.3(17)

5-05.3(19) Reinforced Concrete Bridge Approach Slabs

Approach slab concrete shall be Class 28 conforming to the requirements of Section 6-02.

Reinforced concrete bridge approach slabs shall be constructed at the locations shown in the Plans or as designated by the Engineer and in accordance with the contract documents.

The approach slabs shall be constructed full bridge deck width from outside usable shoulder to outside usable shoulder at an elevation to match the structure. Pavement ends and the bridge ends of the approach slabs shall be constructed as shown in the Plans. The approach slabs shall be modified as shown in the Plans to accommodate the grate inlets at the bridge ends if the grate inlets are required.

Screed rail support, installation, and finish machine requirements shall be as specified for bridge deck slabs.

Reinforced concrete bridge approach slab anchors shall be installed as detailed in the Plans. The anchor rods shall conform to ASTM A 307. The steel plates shall conform to AASHTO M 183M. The anchors shall be installed parallel both to profile grade and center line of roadway. The Contractor shall secure the anchors to ensure that they will not be misaligned during concrete placement. For Method A anchor installations, the grout or adhesive used to install the anchors shall have a minimum compressive strength of 28 megapascals at three days and be capable of developing the ultimate strength of the anchor rod. Compressive strength shall be determined in accordance with AASHTO T 106.

The compression seal shall be as noted in the contract documents.

Finishing of the reinforced concrete bridge approach slabs shall be accomplished by either a combination of finishing machine and hand finishing or by hand finishing methods only. The finished and cured approach slabs shall be free from any deviation exceeding 3 millimeters under a 3-meter straightedge placed parallel and perpendicular to the center line of the roadway. Bridge approach slabs may be opened to traffic in accordance with Section 5-05.3(17). Bridge approach slabs shall be cured in accordance with Section 5-05.3(13).

5-05.3(20) Vacant

5-05.3(21) Vacant

5-05.3(22) Repair of Defective Pavement Slabs

Broken slabs, slabs with random cracks, nonworking contraction joints near cracks, edge slumping and spalls along joints and cracks shall be replaced or repaired as specified at no expense to the Contracting Agency, and shall be accomplished prior to completion of joint sealing.

Pavement slabs containing more than one crack shall be entirely removed and replaced. Pavement slabs containing a single crack shall be removed and replaced such that the minimum dimension of the removed slab is 1.8 meters long and full panel width. The portion of the panel to remain in place shall have a minimum dimension of 1.8 meters in length and full panel width, otherwise entire removal and replacement of the slab is required. There shall be no new joints closer than 0.9 meters to an existing transverse joint. Saw cutting full pavement depth is required along all longitudinal joints and at transverse locations. Tie bars and dowel bars shall be used in accordance Section 5-05.3(10).

Spalls and edge slumping shall be repaired by making vertical saw cuts at least 75 millimeters outside the affected area and to a minimum depth of 75 millimeters. Repair depths that exceed one third of the total slab depth or encounter dowel bars or reinforcing steel will require full depth repair. When the affected area is directly against a longitudinal or transverse joint, a debonding medium, (compressible joint insert or polyethylene strip)

shall be placed between the existing concrete and the area to be patched. For transverse joints, the compressible joint material shall be placed into the existing joint 25 millimeters below the depth of the repair and extended at least 75 millimeters beyond each end of the patch boundry. If the affected area is directly against an asphalt pavement, a formed edge even with the surface is required. The concrete in the affected area shall be chipped out to sound concrete with a pneumatic hammer with a maximum weight of 14 kilograms. The formed cavity shall be sand blasted with dry, oil-free air and thoroughly cleaned of all loose material. Where required a bonding agent shall be applied to the dry, cleaned surface of the cavity in a thin even coat, using a stiff-bristle brush. Placement of Portland cement concrete or epoxy-resin concrete or mortar shall immediately follow the application of the bonding agent. The patch mixture shall be placed and vibrated to eliminate any voids. Vibrators greater than 25 millimeters shall not be used. If cementitious repair material is used, the patch perimeter shall be sealed with a 1:1 cement-water grout. The patch mixture shall be cured according to the manufacture's recommendation.

5-05.4 Measurement

Cement concrete pavement will be measured by the cubic meter for the completed pavement. The volume of the pavement section represented by the reference core shall equal the measured length x width x reference core depth. The volume will be determined from measurements taken as listed below.

1. The width measurement will be the width of the pavement shown on the typical cross-section in the Plans, additional widening where called for, or as otherwise specified in writing by the Engineer.
2. The length will be measured horizontally along the center of each roadway or ramp.
3. The depth will be determined from the reference cores. The depth utilized to calculate the volume shall not exceed the plan depth plus 12 mm.

Epoxy-coated tie bar with drill hole will be measured by the unit for the actual number of bars used in the completed work.

Bridge approach slab will be measured by the square meter.

Cement concrete approach will be measured by the square meter.

The ride smoothness compliance adjustment calculation is the volume of pavement, in cubic meters, represented by the profilogram.

The calculation for Portland cement concrete compliance adjustment is the volume of concrete represented by the CPF and the thickness deficiency adjustment.

5-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Cement Conc. Pavement", per cubic meter.

The unit contract price per cubic meter for "Cement Conc. Pavement" shall include furnishing and installing epoxy coated dowel bars and tie bars, except those tie bars drilled into cement concrete pavement will be paid under the item "Epoxy-Coated Tie Bar with Drill Hole".

"Cement Conc. Approach ____ Day", per square meter.

"Epoxy-Coated Tie Bar with Drill Hole", per each.

"Bridge Approach Slab", per square meter.

The unit contract price per square meter for "Bridge Approach Slab" shall be full pay for providing, placing, and compacting the crushed surfacing top course, furnishing and placing Class 28 concrete, and furnishing and installing compression seal, anchors, and reinforcing steel.

"Ride Smoothness Compliance Adjustment", by calculation.

Payment for "Ride Smoothness Compliance Adjustment" will be calculated by multiplying the unit contract price for cement concrete pavement, times the volume for adjustment, times the percent of adjustment determined from the schedule below.

1. Adjustment will be based on the initial profile index before corrective work.
2. "Ride Smoothness Compliance Adjustment" will be calculated for each 0.1 kilometer section represented by profilogram using the following schedule:

Ride Smoothness Profile Index (millimeters per kilometer)	Compliance Adjustment (percent adjustment)
15 or less	+4
over 15 to 30	+3
over 30 to 45	+2
over 45 to 60	+1
over 60 to 100	0
over 100	-2*

*Also requires correction to 100 millimeters per kilometer.

"Portland Cement Concrete Compliance Adjustment", by calculation.

Payment for "Portland Cement Concrete Compliance Adjustment" will be calculated by multiplying the unit contract price for the cement concrete pavement, times the volume for adjustment times the percent of adjustment determined from the calculated CPF and or the Deficiency Adjustment listed in Section 5-05.5(1)A.

5-05.5(1) Pavement Thickness

It is the intent of the Specifications that cement concrete pavement shall be constructed in accordance with the thickness requirements in the Plans and Specifications. Tolerances allowed for subgrade construction and other provisions which may affect thickness shall not be construed to modify such thickness requirements.

For the purposes of these Specifications, a primary unit of pavement is defined as the area of pavement placed in each day's paving operations. Within such primary unit of pavement, there may be an area or areas which are deficient in thickness by more than 15 millimeters. This deficient area or areas will be defined as a secondary unit or units. If secondary units are found to exist, the primary unit area will be reduced by the secondary unit area included therein. At a time determined by the Engineer, thickness measurements will be made in each primary unit of pavement at the minimum rate of one measurement for each 400 cubic meters of pavement, or fraction thereof. The exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be determined by the Engineer. In general, thickness measurements will be made at uniform intervals throughout each primary unit of pavement.

If thickness deficiencies greater than 15 millimeters are found to exist, supplemental thickness measurements will be made in accordance with Section 5-05.5(1)B. Pavement thickness variations, if any, from the thickness requirements in the Plans and Specifications

will be determined by comparing the actual thickness measurement with the thickness specified at the location where the measurement was made. Such variation will be determined to the nearest 3 millimeters as either excess or deficient thickness.

No challenges shall be allowed to be made for any thickness measurements that indicate a thickness that is within 15 millimeters of the design depth.

5-05.5(1)A Thickness Deficiency of 15 Millimeters or Less

If no thickness measurements in a primary unit are deficient by more than 15 millimeters, all thickness deficiencies in such unit will be averaged to the nearest 3 millimeters to determine the average thickness deficiency, if any, in that primary unit. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than 6 millimeters will be considered to be 6 millimeters greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness by not more than 15 millimeters, the Contractor shall pay to the Contracting Agency, or the Contracting Agency may deduct from any monies due or that may become due the Contractor under the contract, a sum computed by multiplying the deficiency adjustment from the following table by the unit contract price by the volume of such unit.

Average Thickness Deficiency (millimeters)	Deficiency Adjustment (per cubic meter)
3	2%
6	4%
9	9%
12	16%
15	25%

5-05.5(1)B Thickness Deficiency of More Than 15 Millimeters

Where a thickness deficiency greater than 15 millimeters is encountered, the Engineer will determine from supplemental thickness measurements the limits of the secondary unit area. Thickness measurements will be made in each panel of pavement adjacent transversely and longitudinally to the panel of the original measurement. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels with a thickness deficiency of 15 millimeters or less. Cores taken to isolate the secondary unit will not be used to compute average thickness of the primary unit.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges. If longitudinal or transverse joints are eliminated by the Special Provisions, by the Plans, or for any other reasons, the limits of panels will be determined by the Engineer as if such joints had been constructed.

The secondary unit area will be made up of entire panels only. The entire panel will be considered to be of the thickness shown by measurement.

After the Engineer has determined the limits of the secondary unit area, a further determination will be made whether any panels within this area are usable and may be left in place. Following this determination, the Contractor shall remove and replace at no expense to the Contracting Agency such panels as the Engineer may designate in accordance with the following:

If the area to be removed is not bounded by longitudinal or transverse joints, the Contractor shall saw, at no expense to the Contracting Agency, weakened plane joints at the locations designated by the Engineer. The subgrade shall be lowered to meet the

full thickness requirements. The replaced pavement will be tested for thickness by means of additional measurements and will be subject to all of the requirements of the Specifications.

Usable panels may be removed and replaced as outlined above at the option of the Contractor, or these panels will be permitted to remain in place, provided that no payment will be made for any panels which are left in place, and that a further penalty will be assessed in the amount of 25 percent of the Contractor's unit bid price for all such panels. The Contracting Agency may deduct such amount from any monies due or that may become due the Contractor under the Contract.

The cost of all thickness measurements made to determine the secondary unit areas, including filling the core holes with concrete, will be deducted at the rate of $150.00 per core from any monies due or that may become due the Contractor under the Contract.

All additional work required and any delay to the Contractor's operations as a result of this Specification shall not be cause for additional pay nor for an extension of time.

DIVISION 6
STRUCTURES

6-01 GENERAL REQUIREMENTS

6-01.1 Description

This section relates to structural and incidental items used in any or all types of existing or proposed structures. These provisions supplement the detailed specifications supplied for any given structure. These provisions apply only when relevant and when they do not conflict with the Plans or Special Provisions.

6-01.2 Foundation Data

Foundation data in the Plans (from test borings, test pits, or other sources) were obtained only to guide the Department in planning and designing the project. These data reasonably represent the best information available to the Department concerning conditions and materials at the test sites at the time the investigations were made.

6-01.3 Clearing the Site

The Contractor shall clear the entire site of the proposed structure to the limits staked by the Engineer.

6-01.4 Appearance of Structures

To achieve a more pleasing appearance, the Engineer may require the Contractor to adjust the height and alignment of bridge railings, traffic barrier, and structural curbs.

6-01.5 Vacant

6-01.6 Load Restrictions on Bridges Under Construction

Bridges under construction shall remain closed to all traffic, including construction equipment, until the substructure and the superstructure, through the roadway deck, are complete for the entire structure, except as provided herein. Completion includes release of all falsework, removal of all forms, and attainment of the minimum design concrete strength and specified age of the concrete in accordance with these Specifications. Once the structure is complete, Section 1-07.7 shall govern all traffic loading, including construction traffic (equipment).

If necessary and safe to do so, and if the Contractor requests it in writing, the Engineer may approve traffic on a bridge prior to completion. The written request shall:

1. Describe the extent of the structure completion at time of the proposed equipment loading;
2. Describe the loading arrangement, movement, and position of traffic (equipment) on the bridge;
3. Provide stress calculations prepared by (or under the direction of) a professional engineer, licensed under Title 18 RCW, state of Washington, and carrying the professional engineer's signature and seal; and
4. State that the Contractor assumes all risk for damage.

Construction traffic shall not occupy the structure until the Engineer's approval has been obtained in writing.

Contract prices shall cover all costs associated with preparation and submittal of the request and operation of approved traffic (equipment) as outlined herein. Nothing in this section affects the Contractor's other responsibilities under these Specifications or under public highway laws.

6-01.7 Navigable Streams

The Contractor shall keep navigable streams clear so that water traffic may pass safely, providing and maintaining all lights and signals required by the U.S. Coast Guard. The Contractor shall also comply with all channel depth and clearance line requirements of the U.S. Corps of Engineers. This may require removing material deposited in the channel during construction.

6-01.8 Approaches to Movable Spans

No roadway or sidewalk slab on the approach span at either end of a movable span may be placed until after the movable span has been completed, adjusted and closed.

6-01.9 Working Drawings

The Contractor shall submit supplemental working drawings with calculations as required for the performance of the work. The drawings shall be on sheets measuring 560 m by 865 mm, 280 mm by 430 mm, or on sheets with dimensions in multiples of 215 mm by 280 mm. All drawings shall be to scale in keeping with standard drafting procedures. The design calculations shall be on sheets measuring 215 mm by 280 mm. They shall be legible, with all terms identified, and may include computer printouts. The drawings and calculations shall be provided far enough in advance of actual need to allow for the review process by the Contracting Agency, which may involve rejection, revision, or resubmittal. Unless otherwise stated in the contract, the Engineer will require up to 30 calendar days from the date the submittals are received until they are sent to the Contractor. This time will increase if the drawings submitted do not meet the contract requirements or contain insufficient details.

Unless designated otherwise by the Contractor, submittals of working drawing plans will be reviewed in the order they are received by the Engineer. In the event that several working drawing plans are submitted simultaneously, the Contractor shall specify the sequence in which these plans are to be reviewed. The Engineer's review time shall be as specified above for the first plan in the specified sequence and up to an additional two weeks for each plan lower in the specified sequence. A plan is defined as one or more working drawings that pertain to a unit of superstructure or a complete pier. If the Contractor does not submit a working drawing review sequence for simultaneous plan submittals, the review sequence shall be at the Engineer's discretion.

Working drawings and calculations shall be prepared by (or under the direction of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, and shall carry the Professional Engineer's signature and seal.

If more than the specified number of days are required for the Engineer's review of any individual submittal or resubmittal, an extension of time will be considered in accordance with Section 1-08.8.

6-01.10 Vacant

6-01.11 Name Plates

The Contractor shall install no permanent plates or markers on a structure unless the Plans show it.

6-01.12 Final Cleanup

When the structure is completed, the Contractor shall leave it and the entire site in a clean and orderly condition. Structure decks shall be swept and washed. Temporary buildings, falsework, piling, lumber, equipment, and debris shall be removed. The Contractor shall level and fine grade all excavated material not used for backfill, and shall fine grade all slopes and around all piers, bents, and abutments.

The Contractor is advised that after the structure is complete, a representative(s) of the Department's Bridge Condition Unit may perform an Inventory Inspection of the structure. The purpose of the Inventory Inspection is to field verify certain contract details, to provide a base-line condition assessment of the structure, and to identify any potential maintenance features.

6-01.13 Architectural Features

To ensure uniform texture and color, the Contractor shall obtain all cement for the structure from the same manufacturing plant unless the Engineer waives this requirement in writing.

6-01.14 Premolded Joint Filler

When the Plans call for premolded joint filler, the Contractor shall fasten it with galvanized wire nails to one side of the joint. The nails must be no more than 150 millimeters apart and shall be 38 millimeters from the edges over the entire joint area. The nails shall be at least 38 millimeters longer than the thickness of the filler.

The Contractor may substitute for the nails any adhesive approved by the Engineer. This adhesive, however, shall be compatible with Resilient Bituminous Preformed Expansion Joint Filler (ASTM D 1751) and capable of bonding the filler to Portland cement concrete.

6-01.15 Normal Temperature

Bridge plans state dimensions at a normal temperature of 18°C. Unless otherwise noted, these dimensions are horizontal or vertical.

6-02 CONCRETE STRUCTURES

6-02.1 Description

Section 6-02 applies to the construction of all structures (and their parts) made of Portland cement concrete with or without reinforcement. Any part of a structure to be made of other materials shall be built as these Specifications require elsewhere.

6-02.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Gravel Backfill	9-03.12
Joint and Crack Sealing Materials	9-04
Reinforcing Steel	9-07
Epoxy-Coated Reinforcing Steel	9-07
Prestressed Concrete Girders	9-19
Curing Materials and Admixtures	9-23
Fly Ash	9-23
Plastic Waterstop	9-24
Water	9-25
Elastomeric Bearing Pads	9-31

6-02.3 Construction Requirements

6-02.3(1) Classification of Structural Concrete

The class of concrete to be used shall be as noted in the Plans and these Specifications. The numerical class of concrete defines the specified minimum compressive strength at 28 days in accordance with AASHTO T 22. The letter designation following the class of concrete identifies the specific use; P for Piling applications, W for Underwater applications, and D for Deck applications

The Contractor may request, in writing, permission to use a different class of concrete with either the same or a higher compressive strength than specified. The substitute concrete shall be evaluated for acceptance based on the specified class of concrete. The Engineer will respond in writing. The Contractor shall bear any added costs that result from the change.

6-02.3(2) Proportioning Materials

The total water soluble Chloride ion (Cl^-) content of the mixed concrete shall not exceed 0.06 percent by mass of cementitious material for prestressed concrete nor 0.10 percent by mass of cementitious material for reinforced concrete. An initial evaluation may be obtained by testing individual concrete ingredients for total chloride ion content per AASHTO T 260 and totaling these to determine the total water soluble Chloride ion (Cl^-) or the total water soluble Chloride ion (Cl^-) in accordance with ASTM C 1218. Cementitious material shall be the mass of cement plus fly ash, and microsilica.

Unless otherwise specified, the Contractor shall use Type I or II Portland cement in all concrete as defined in Section 9-01.2(1).

The use of fly ash is required for Class 28D and 28P and optional for all other classes of concrete except when required for the mitigation of Alkali Silica Reactivity. Fly ash, if used, shall not exceed 25 percent by mass of the total cementitious material, except when

required for the mitigation of Alkali Silica Reactivity, in the concrete mix and all concrete within a class in a structure shall have the same proportion of fly ash. The water/cement ratio shall be calculated on the total cementitious material. As an alternative to the use of cement and fly ash as separate components, a blended hydraulic cement, Type IP or Type I (PM), may be used.

6-02.3(2)A Contractor Mix Design

The Contractor shall provide a mix design in writing to the Engineer for all classes of concrete specified in the Plans except for those accepted based on a Certificate of Compliance. No concrete shall be placed until the Engineer has reviewed the mix design. The required average 28 day compressive strength shall be selected per ACI 318, chapter 5, Section 5.3.2. ACI 211.1 and ACI 318 shall be used to determine proportions. The proposed mix for Class 28P shall provide a minimum fly ash content per cubic meter of 60 kilograms and a minimum cement content per cubic meter of 360 kilograms. The proposed mix for Class 28D shall provide a minimum fly ash content per cubic meter of 45 kilograms and a minimum cement content per cubic meter of 390 kilograms. All other concrete mix designs, except those for lean concrete, shall have a minimum cementitious material content of 335 kg per cubic meter of concrete.

The Contractor's submittal of a mix design shall be on WSDOT Form 350-040 and shall provide a unique identification for each mix design and shall include the mix proportions per cubic meter, the proposed sources, the average 28 day compressive strength for which the mix is designed, the fineness modulus, water cement ratio, and the aggregate correction factor per AASHTO T 152. Concrete placeability, workability, and strength shall be the responsibility of the Contractor. The Contractor shall notify the Engineer in writing of any mix design modifications.

Fine aggregate shall conform to Section 9-03.1(2) Class 1 or Class 2.

Coarse aggregate shall conform to Section 9-03. The nominal maximum size aggregate for Class 28P shall be 12.5 millimeters. The nominal maximum size aggregate for Class 28D shall be 19 millimeters. Nominal maximum size for concrete aggregate is defined as the smallest standard sieve opening through which the entire amount of the aggregate is permitted to pass.

Class 28D and 28 P concrete shall include a water reducing admixture in the amount recommended by the manufacturer. A retarding admixture is required in concrete Class 28P. Water reducing and retarding admixtures are optional for all other concrete classes.

A high-range water reducer (superplasticizer) may be used in all mix designs. The use of a high-range water reducer shall be submitted as a part of the Contractor's concrete mix design.

Air content shall be a minimum of 4.5 percent and a maximum of 7.5 percent for all concrete placed above the finished ground line.

6-02.3(2)B Commercial Concrete

Where concrete Class 20 is specified for items such as, culvert headwalls, plugging culverts, concrete pipe collars, pipe anchors, monument cases, luminaire bases, pedestals, cabinet bases, guardrail anchors, sign post foundations, fence post footings, sidewalks, curbs, and gutters, the Contractor may use commercial concrete. Commercial concrete shall not be used for bridges, retaining walls, box culverts, or foundations for high mast luminaires, mast arm traffic signals, cantilever signs, and sign bridges. For items not listed, the Contractor may use commercial concrete if approved by the Engineer.

Commercial class concrete shall have a minimum compressive strength at 28 days of 20 MPa in accordance with AASHTO T 22.

6-02.3(2)C Vacant

6-02.3(2)D Lean Concrete

Lean concrete shall contain between 85 and 120 kilograms of cement per cubic meter and have a maximum water/cement ratio of 2.

6-02.3(3) Admixtures

Concrete admixtures shall be added to the concrete mix at the time of batching the concrete or in accordance with the manufacturer's written procedure and as approved by the Engineer. A copy of the manufacturer's written procedure shall be furnished to the Engineer prior to use of any admixture. Any deviations from the manufacturer's written procedures shall be submitted to the Engineer for approval. Admixtures shall not be added to the concrete with the modified procedures until the Engineer has approved them in writing.

When the Contractor is proposing to use admixtures from different admixture manufacturers they shall provide evidence to the Engineer that the admixture will be compatible and not adversely effect the air void system of the hardened concrete. Test results complying with ASTM C 457 shall be provided as the evidence to satisfy this requirement. Admixture combinations which have been previously tested and which are in compliance with ASTM C 457 shall be listed in the Qualified Products List (QPL). Proposed combinations not found in the QPL shall meet this requirement.

Accelerators shall not be used.

Air entrained cement shall not be used to air entrain concrete.

6-02.3(4) Ready-Mix Concrete

All concrete, except commercial concrete and lean concrete shall be batched in a prequalified manual, semi-automatic, or automatic plant as described in Section 6-02.3(4)A. If the plant has not been prequalified, the Contractor shall provide written notification to the Engineer two weeks prior to anticipated use of the batch plant to allow for Contracting Agency inspection. Information concerning NRMCA certification may be obtained from the National Ready Mix Concrete Association at 900 Spring Street, Silver Springs, MD 20910. The Engineer is not responsible for any delays to the Contractor due to problems in getting the plant certified.

6-02.3(4)A Qualification of Concrete Suppliers

Prequalification may be obtained through an inspection conducted by the Contracting Agency, or as an alternate, through certification by NRMCA or by an independent evaluation certified by a professional engineer using NRMCA or Contracting Agency guidelines. The Contracting Agency inspection and the NRMCA certification have similar requirements for plant and delivery equipment. Prequalification shall be good for a two year period.

For central-mixed concrete, the mixer shall be equipped with a timer that prevents the batch from discharging until the batch has been mixed for the prescribed mixing time. A mixing time of one minute will be required after all materials and water have been introduced into the drum. Shorter mixing time may be allowed if the mixer performance is tested in accordance with (AASHTO M 157 Annex A1 Concrete Uniformity Requirements).

Tests shall be conducted by an independent testing lab or by a commercial concrete producer's lab. If the tests are performed by a producer's lab, the Engineer or a representative will witness all testing.

For shrink-mixed concrete, the mixing time in the stationary mixer shall not be less than 30 seconds or until the ingredients have been thoroughly blended.

For transit-mixed or shrink-mixed concrete, the mixing time in the transit mixer shall be a minimum of 70 revolutions at the mixing speed designated by the manufacturer of the mixer. Following mixing, the concrete in the transit mixer may be agitated at the manufacturer's designated agitation speed. A maximum of 320 revolutions (total of mixing and agitation) will be permitted prior to discharge.

All transit-mixers shall be equipped with an operational revolution counter and a functional device for measurement of water added. All mixing drums shall be free of concrete buildup and the mixing blades shall meet the minimum Specifications of the drum manufacturer. A copy of the manufacturer's blade dimensions and configuration shall be on file at the concrete producer's office. A clearly visible metal data plate (or plates) attached to each mixer and agitator shall display: (1) the maximum concrete capacity of the drum or container for mixing and agitating, and (2) the rotation speed of the drum or blades for both the agitation and mixing speeds. Mixers and agitators shall always operate within the capacity and speed-of-rotation limits set by the manufacturer. Any mixer, when fully loaded, shall keep the concrete uniformly mixed. All mixers and agitators shall be capable of discharging the concrete at a steady rate. Only those transit-mixers which meet the above requirements will be allowed to deliver concrete to any Contracting Agency project covered by these Specifications.

In transit-mixing, mixing shall begin within 30 seconds after the cement is added to the aggregates.

Central-mixed concrete, transported by truck mixer/agitator, shall not undergo more than 250 revolutions of the drum or blades before beginning discharging. To remain below this limit, the suppler may agitate the concrete intermittently within the prescribed time limit. When water or admixtures are added after the load is initially mixed, an additional 70 revolutions will be required at the recommended mixing speed.

For each project, at least biannually, or as required, the Engineer will examine mixers and agitators to check for any buildup of hardened concrete or worn blades. If this examination reveals a problem, or if the Engineer wishes to test the quality of the concrete, slump tests may be performed with samples taken at approximately the 1 /4 and 3 /4 points as the batch is discharged. The maximum allowable slump difference shall be as follows:

If the average of the two slump tests is $\leq$ 100 millimeters, the difference shall be $\leq$ 25 millimeters or if the average of the two slump tests is >100 millimeters, the difference shall be $\leq$ 38 millimeters.

If the slump difference exceeds these limits, the equipment shall not be used until the faulty condition is corrected. However, the equipment may continue in use if longer mixing times or smaller loads produce batches that pass the slump uniformity tests.

All concrete production facilities will be subject to verification inspections at the discretion of the Engineer. Verification inspections are a check for: current scale certifications; accuracy of water metering devices; accuracy of the batching process; and verification of coarse aggregate quality.

If the concrete producer fails to pass the verification inspection, the following actions will be taken:

1. For the first violation, a written warning will be provided.

2. For the second violation, the Engineer will give written notification and the Contracting Agency will assess a price reduction equal to 15 percent of the invoice cost of the concrete that is supplied from the time of the infraction until the deficient condition is corrected.
3. For the third violation, the concrete supplier is suspended from providing concrete until all such deficiencies causing the violation have been permanently corrected and the plant and equipment have been reinspected and meets all the prequalification requirements.
4. For the fourth violation, the concrete supplier shall be disqualified from supplying concrete for one year from the date of disqualification. At the end of the suspension period the concrete supplier may request that the facilities be inspected for prequalification.

6-02.3(4)B Jobsite Mixing

For small quantities of concrete, the Contractor may mix concrete on the job site provided the Contractor has requested in writing and received written permission from the Engineer. The Contractor's written request shall include a mix design, batching and mixing procedures, and a list of the equipment performing the job-site mixing. All job site mixed concrete shall be mixed in a mechanical mixer.

If the Engineer permits, hand mixing of concrete will be permitted for pipe collars, pipe plugs, fence posts, or other items approved by the Engineer, provided the hand mixing is done on a watertight platform in a way that distributes materials evenly throughout the mass. Mixing shall continue long enough to produce a uniform mixture. No hand mixed batch shall exceed 1/2 cubic meter.

Concrete mixed at the jobsite is never permitted for placement in water.

6-02.3(4)C Consistency

The maximum slump for concrete shall be:

1. 90 millimeters for vibrated concrete placed in all bridge roadway slabs, bridge approach slabs, and flat slab bridge superstructures.
2. 115 millimeters for all other vibrated concrete.
3. 180 millimeters for non-vibrated concrete. (Includes Class 28P)

When a high range water reducer is used, the maximum slump listed above may be increased an additional 50 millimeters.

6-02.3(4)D Temperature and Time For Placement

Concrete temperatures shall remain between 13°C and 32°C while it is being placed. Precast concrete that is heat cured per Section 6-02.3(25)D shall remain between 10°C and 32°C while being placed. The batch of concrete shall be discharged at the project site no more than $1^1/_2$ hours after the cement is added to the concrete mixture. The time to discharge may be extended to $1^3/_4$ hours if the temperature of the concrete being placed is less than 24°C. With the approval of the Engineer and as long as the temperature of the concrete being placed is below 24°C, the maximum time to discharge may be extended to two hours. When conditions are such that the concrete may experience an accelerated initial set, the Engineer may require a shorter time to discharge. The time to discharge may be extended upon written request from the Contractor. This time extension will be considered on a case by case basis and requires the use of specific retardation admixtures and the approval of the Engineer.

6-02.3(5) Acceptance of Concrete

6-02.3(5)A General

Lean concrete and commercial concrete will be accepted based on a Certificate of Compliance to be provided by the supplier as described in Section 6-02.3(5)B.

All other concrete will be accepted based on conformance to the requirement for temperature, slump, air content for concrete placed above finished ground line, and the specified compressive strength at 28 days for sublots as tested and determined by the Contracting Agency.

A sublot is defined as the material represented by an individual strength test. An individual strength test is the average compressive strength of cylinders from the same sample of material.

Each sublot will be deemed to have met the specified compressive strength requirement when both of the following conditions are met:

1. Individual strength tests do not fall below the specified strength by more than 12½ percent or 3.5 MPa, whichever is least.
2. An individual strength test averaged with the two proceeding individual strength tests meets or exceeds specified strength (for the same class of concrete on the same contract).

When compressive strengths fail to satisfy one or both of the above requirements, the Contractor may:

1. Request acceptance based on the Contractor/Suppliers strength test data for cylinders made from the same truckload of concrete as the Contracting Agency cylinders provided:
   a. The Contractor's test results are obtained from testing cylinders fabricated, handled, and stored for 28 days in accordance with Field Operating Procedure for AASHTO T 23 or the Field Operating Procedure for AASHTO T 23 and tested in accordance with AASHTO T 22. The test cylinders shall be the same size cylinders as those cast by the Contracting Agency.
   b. The technician fabricating the cylinders is qualified by either ACI, Grade 1 or WAQTC to perform this work.
   c. The laboratory performing the tests per AASHTO T 22 has an equipment calibration/certification system, and a technician training and evaluation process per AASHTO R-18.
   d. Both the Contractor and Contracting Agency have at least 15 test results from the same mix to compare. The Contractor's results could be used if the Contractor's computed average of all their test results is within one standard deviation of the Contracting Agency's average test result. The computed standard deviation of the Contractor's results must also be within plus or minus 1.5 MPa of the Contracting Agency's standard deviation.
2. Request acceptance of in-place concrete strength based on core results. This method will not be used if the Engineer determines coring would be harmful to the integrity of the structure. Cores, if allowed, will be obtained by the Contractor in accordance with AASHTO T 24 and delivered to the Contracting Agency for testing in accordance with AASHTO T 22. If the concrete in the structure will be dry under service conditions, the core will be air dried at a temperature of between 16°C and 27°C and at a relative humidity of less than 60 percent for seven days before testing, and will be tested air dry.

Acceptance for each sublot by the core method requires that the average compressive strength of three cores be at least 85 percent of the specified strength with no one core less than 75 percent of the specified strength. When the Contractor requests strength analysis by coring, the results obtained will be accepted by both parties as conclusive and supersede all other strength data for the concrete sublot.

If the Contractor elects to core, cores shall be obtained no later than 50 days after initial concrete placement. The Engineer will concur in the locations to be cored. Repair of cored areas shall be the responsibility of the Contractor. The cost incurred in coring and testing these cores, including repair of core locations, shall be borne by the Contractor.

6-02.3(5)B Certification of Compliance

The concrete producer shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall verify that the delivered concrete is in compliance with the mix design and shall include:

- Manufacturer plant (batching facility)
- Contracting Agency contract number.
- Date
- Time batched
- Truck No.
- Initial revolution counter reading
- Quantity (quantity batched this load)
- Type of concrete by class and producer design mix number
- Cement producer, type, and Mill Certification No. (The mill test number as required by Section 9-01.3 is the basis for acceptance of cement.)
- Fly ash (if used) brand and Type
- Approved aggregate gradation designation

Mix design masses per cubic meter and actual batched masses for:

- Cement
- Fly ash (if used)
- Coarse concrete aggregate and moisture content (each size)
- Fine concrete aggregate and moisture content
- Water (including free moisture in aggregates)
- Admixtures brand and total quantity batched
  - Air-entraining admixture
  - Water reducing admixture
  - Other admixture

The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use the Contracting Agency-provided printed forms, which shall be completed for each load of concrete delivered to the project.

6-02.3(5)C Conformance to Mix Design

Aggregate masses shall conform within plus or minus 2 percent of the masses for coarse or fine aggregate required by the mix design. The total cementitious material mass shall conform within plus or minus 1 percent of that specified in the mix design. If the total cementitious material mass is made up of different components, these component masses shall be within the following tolerances:

1. Portland cement mass plus or minus 1 percent of that specified in the mix design.
2. Fly ash mass plus or minus 5 percent of that specified in the mix design.
3. Microsilica mass plus or minus 10 percent of that specified in the mix design.

Water shall not exceed the maximum water specified in the mix design.

6-02.3(5)D Test Methods

Acceptance testing will be performed by the Contracting Agency in accordance with the AASHTO Field Operating Procedures set forth in the WSDOT Materials Manual. AASHTO Field Operating Procedures to be used with this specification are:

AASHTO T 22	Compressive Strength of Cylindrical Concrete Specimens
AASHTO T 23	Making and Curing Concrete Test Specimens in the Field
AASHTO T 119	Slump of Hydraulic Cement Concrete
AASHTO T 141	Sampling Freshly Mixed Concrete or Western Alliance for Quality Transportation Construction (WAQTC) TM 2
AASHTO T 152	Air Content of Freshly Mixed Concrete by the Pressure Method
AASHTO T 231	Capping Cylindrical Concrete Specimens
ASTM C 1064	Temperature of Freshly Mixed Portland Cement Concrete or WAQTC TM 10

6-02.3(5)E Point of Acceptance

Determination of concrete properties for acceptance will be made based on samples taken as follows:

Bridge decks, overlays, and barriers at the discharge of the placement system. All other placements at the truck discharge.

It shall be the Contractor's responsibility to provide adequate and representative samples of the fresh concrete to a location designated by the Engineer for the testing of concrete properties and making of cylinder specimens. Samples shall be provided as directed in Sections 1-06.1 and 1-06.2.

6-02.3(5)F Water/Cement Ratio Conformance

The actual water cement ratio shall be determined from the certified proportions of the mix, adjusting for on the job additions. No water may be added after acceptance testing or after placement has begun, except for concrete used in slip forming. For slip-formed concrete, water may be added during placement but shall not exceed the maximum water cement ratio in the mix design, and shall meet the requirements for consistency as described in Section 6-02.3(4)C. If water is added, an air and temperature test shall be taken prior to resuming placement to ensure that specification conformance has been maintained.

6-02.3(5)G Sampling and Testing Frequency for Temperature, Consistency, and Air Content

Concrete properties shall be determined from concrete as delivered to the project and as accepted by the Contractor for placement. The Contracting Agency will test for acceptance of concrete for slump, temperature, and air content, if applicable, as follows:

Sampling and testing will be performed before concrete placement from the first truck load. Concrete shall not be placed until tests for slump, temperature, and entrained air (if applicable) have been completed by the Engineer, and the results indicate that the concrete is within acceptable limits. Except for the first load of concrete, up to

0.4 cubic meter may be placed prior to testing for acceptance. Sampling and testing will continue for each load until two successive loads meet all applicable acceptance test requirements. After two successive tests indicate that the concrete is within specified limits, the sampling and testing frequency may decrease to one for every five truck loads. Loads to be sampled will be selected in accordance with the random selection process as outlined in Field Operating Procedure for AASHTO T 141 Section 4 or Western Alliance for Quality Transportation Construction (WAQTC) TM 2, appendix 1.

When the results for any subsequent acceptance test indicates that the concrete as delivered and approved by the Contractor for placement does not conform to the specified limits, the sampling and testing frequency will be resumed for each truck load. Whenever two successive subsequent tests indicate that the concrete is within the specified limits, the random sampling and testing frequency of one for every five truck loads may resume.

Sampling and testing for a placement of one class of concrete consisting of 40 cubic meters or less will be as listed above, except:

Sampling and testing will continue until one load meets all of the applicable acceptance requirements, and

After one set of tests indicate that the concrete is within specified limits, the remaining concrete to be placed may be accepted by visual inspection.

6-02.3(5)H Sampling and Testing for Compressive Strength

Acceptance testing for compressive strength shall be conducted at the same frequency as the acceptance tests for temperature, consistency, and air content.

6-02.3(5)I Vacant

6-02.3(5)J Vacant

6-02.3(5)K Rejecting Concrete

Rejection Without Testing — The Engineer, prior to sampling, may reject any batch or load of concrete that appears defective in composition; such as cement content or aggregate proportions. Rejected material shall not be incorporated in the structure.

6-02.3(5)L Concrete With Non-Conforming Strength

Concrete with cylinder compressive strengths (fc) which fails to meet acceptance level requirements shall be evaluated for structural adequacy. If the material is found to be adequate, payment shall be adjusted in accordance with the following formula:

$$\text{Pay adjustment} = \frac{2(f'c - fc)(UP)(Q)}{f'c}$$

where
- $f'c$ = Specified minimum compressive strength at 28 days.
- fc = Compressive strength at 28 days as determined by AASHTO Test Methods.
- UP = Unit contract price per cubic meter for the class of concrete involved.
- Q = Quantity of concrete represented by an acceptance test based on the required frequency of testing.

Concrete that fails to meet minimum acceptance levels using the coring method will be evaluated for structural adequacy. If the material is found to be adequate, payment shall be adjusted in accordance with the following formula:

$$\text{Pay adjustment} = \frac{3.56(.85f'c\text{-}f\ cores)(UP)(Q)}{f'c}$$

where	f′c	=	Specified minimum compressive strength at 28 ays.
	f cores	=	Compressive strength of the cores as determined by AASHTO T-22.
	UP	=	Unit contract price per cubic meter for the class of concrete involved.
	Q	=	Quantity of concrete represented by an acceptance test based on the required frequency of testing.

Where these Specifications designate payment for the concrete on other than a per cubic meter basis, the unit contract price of concrete shall be taken as $390 per cubic meter for concrete Class 28, 35, and 43. For concrete Class 20, the unit contract price for concrete shall be $210 per cubic meter.

Section 6-02.3(5)M Vacant

6-02.3(6) Placing Concrete

The Contractor shall not place concrete:

1. On frozen or ice-coated ground or subgrade;
2. Against or on ice-coated forms, reinforcing steel, structural steel, conduits, precast members, or construction joints;
3. Under rainy conditions; placing of concrete shall be stopped before the quantity of surface water is sufficient to affect or damage surface mortar quality or cause a flow or wash the concrete surface;
4. In any foundation until the Engineer has approved its depth and character;
5. In any form until the Engineer has approved it and the placement of any reinforcing in it; or
6. In any work area when vibrations from nearby work may harm the concrete's initial set or strength.

When a foundation excavation contains water, the Contractor shall pump it dry before placing concrete. If this is impossible, an underwater concrete seal shall be placed that complies with Section 6-02.3(6)B. This seal shall be thick enough to resist any uplift.

All foundations and forms shall be moistened with water just before the concrete is placed. Any standing water on the foundation or in the form shall be removed.

The Contractor shall place concrete in the forms as soon as possible after mixing. The concrete shall always be plastic and workable. For this reason, the Engineer may reduce the time to discharge even further. Concrete placement shall be continuous, with no interruption longer than 30 minutes between adjoining layers unless the Engineer approves a longer time. Each layer shall be placed and consolidated before the preceding layer takes initial set. After initial set, the forms shall not be jarred, and projecting ends of reinforcing bars shall not be disturbed.

In girders or walls, concrete shall be placed in continuous, horizontal layers 0.5 to 0.6 meter deep. Compaction shall leave no line of separation between layers. In each part of a form, the concrete shall be deposited as near its final position as possible.

Any method for placing and consolidating shall not segregate aggregates or displace reinforcing steel. Any method shall leave a compact, dense, and impervious concrete with smooth faces on exposed surfaces. Plastering is not permitted. Any section of defective concrete shall be removed at the Contractor's expense.

To prevent aggregates from separating, the length of any conveyor belt used to transport concrete shall not exceed 90 meters. If the mix needs protection from sun or rain, the Contractor shall cover the belt. When concrete pumps are used for placement, the operator(s) shall be certified by the American Concrete Pumping Association for the type of equipment and class of concrete to be placed. Prior to use on the first placement of each day a Contractor's representative shall visually inspect the pumps water chamber for water leakage. No pump shall be used that allows free water to flow past the piston.

If a concrete pump is used as the placing system, the pump priming slurry shall be discarded before placement. Initial acceptance testing may be delayed until the pump priming slurry has been eliminated from the concrete being pumped. Eliminating the priming slurry from the concrete may require that several cubic meters of concrete are discharged through the pumping system and discarded. Use of a concrete pump requires a reserve pump (or other backup equipment) at the site.

If the concrete will drop more than 1.5 meters, it shall be deposited through a sheet metal (or other approved) conduit. If the form slopes, the concrete shall be lowered through approved conduit to keep it from sliding down one side of the form. No aluminum conduits or tremies shall be used to pump or place concrete.

Before placing concrete for roadway slabs on steel spans, the Contractor shall release the falsework under the bridge and let the span swing free on its supports. Concrete in flat slab bridges shall be placed in one continuous operation for each span or series of continuous spans.

Concrete for roadway slabs and the stems of T-beams or box-girders shall be placed in separate operations if the stem of the beam or girder is more than 0.9 meters deep. First the beam or girder stem shall be filled to the bottom of the slab fillets. Roadway slab concrete shall not be placed until enough time has passed to permit the earlier concrete to shrink (at least 12 hours). If stem depth is 0.9 meters or less, the Contractor may place concrete in one continuous operation if the Engineer approves.

Between expansion or construction joints, concrete in beams, girders, roadway slabs, piers, columns, walls, and traffic and pedestrian barriers, etc., shall be placed in a continuous operation.

No traffic or pedestrian barrier shall be placed until after the roadway slabs are complete for the entire structure. No concrete barriers shall be placed until the falsework has been released and the span supports itself. No barrier, curb, or sidewalk shall be placed on steel or prestressed concrete girder bridges until the roadway slab reaches a compressive strength of at least 20 megapascals.

The Contractor may construct traffic and pedestrian barriers by the slipform method. However, the barrier may not deviate more than 6 millimeters when measured by a 3-meter straightedge held longitudinally on the front face, back face, and top surface. Electrical conduit within the barrier shall be constructed in accordance with the requirements of Section 8-20.3(5).

When placing concrete in arch rings, the Contractor shall ensure that the load on the falsework remains symmetrical and uniform.

Unless the Engineer approves otherwise, arch ribs in open spandrel arches shall be placed in sections. Small key sections between large sections shall be filled after the large sections have shrunk.

6-02.3(6)A Weather and Temperature Limits to Protect Concrete

HOT WEATHER PROTECTION

The Contractor shall provide concrete within the specified temperature limits by:

1. Shading or cooling aggregate piles (sprinkling of fine aggregate piles with water is not allowed). If sprinkling of the coarse aggregates is to be used, the piles moisture content shall be monitored and the mixing water adjusted for the free water in the aggregate. In addition, when removing the coarse aggregate, it shall be removed from at least 0.3 meter above the bottom of the pile.
2. Refrigerating mixing water; or replacing all or part of the mixing water with crushed ice, provided the ice is completely melted by placing time.

If the concrete would probably exceed 32°C using normal methods, the Engineer may require approved temperature-reduction measures be taken before the placement begins.

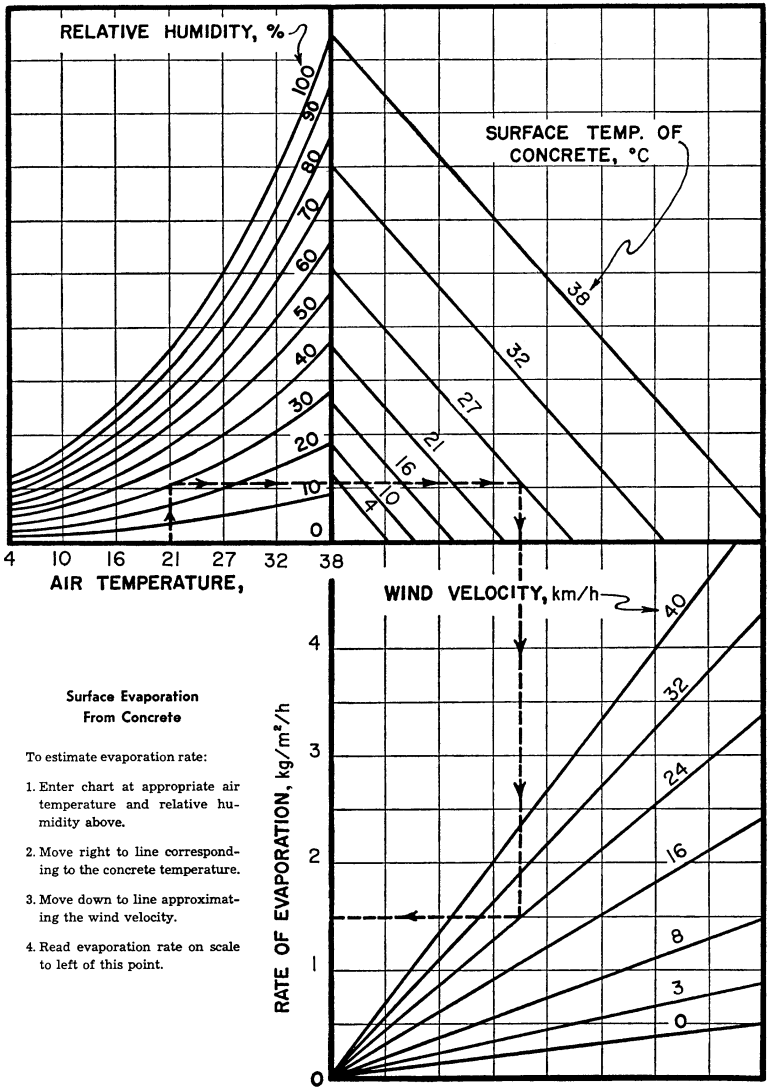
If air temperature exceeds 32°C, the Contractor shall use water spray or other approved methods to cool all concrete-contact surfaces to less than 32°C. These surfaces include forms, reinforcing steel, steel beam flanges, and any others that touch the mix. The Contractor shall reduce the time between mixing and placing to a minimum and shall not permit mixer trucks to remain in the sun while waiting to discharge concrete. Chutes, conveyors, and pump lines shall be shaded.

If bridge roadway slabs are placed while air temperature exceeds 32°C, the Contractor shall:

1. Cover the top layer of reinforcing steel with clean, wet burlap immediately before concrete placement;
2. Sprinkle cool water on the forms and reinforcing steel just before the placement if the Engineer requires it;
3. Finish the concrete slab without delay; and
4. Provide at the site water-fogging equipment to be used if needed after finishing to prevent plastic cracks.

If the evaporation rate at the concreting site is 1 kilogram per square meter per hour or more (determined from Table 6-02.3(6)), the Contractor shall surround the fresh concrete with an enclosure. This enclosure will protect the concrete from wind blowing across its surface until the curing compound is applied. If casting deck concrete that is 27°C or hotter, the Contractor shall install approved equipment at the site to show relative humidity and wind velocity.

Table 6-02.3(6) Surface Evaporation from Concrete



Surface Evaporation From Concrete

To estimate evaporation rate:

1. Enter chart at appropriate air temperature and relative humidity above.
2. Move right to line corresponding to the concrete temperature.
3. Move down to line approximating the wind velocity.
4. Read evaporation rate on scale to left of this point.

COLD WEATHER PROTECTION

The Contractor shall provide a written procedure for cold weather concreting to the Engineer for review and approval. Permission given by the Engineer to place concrete during cold weather will in no way ensure acceptance of the work by the Contracting Agency. Should the concrete placed under such conditions prove unsatisfactory in any way, the Engineer shall still have the right to reject the work although the plan and the work was carried out with his permission.

The Engineer may require the Contractor to provide and maintain a recording thermometer near the concreting site. During freezing or near-freezing weather, data from this thermometer shall be readily available to the Engineer.

The Contractor shall not mix nor place concrete while the air temperature is below 2°C, unless the water or aggregates (or both) are heated to at least 21°C. The aggregate shall not exceed 66°C. If the water is heated to more than 66°C, it shall be mixed with the aggregates before the cement is added. Any equipment and methods shall heat the materials evenly.

The Contractor may warm stockpiled aggregates with dry heat or steam, but not by applying flame directly or under sheet metal. If the aggregates are in bins, steam or water coils or other heating methods may be used if aggregate quality is not affected. Live steam heating is not permitted on or through aggregates in bins. If using dry heat, the Contractor shall increase mixing time enough to permit the super-dry aggregates to absorb moisture.

Any concrete placed in air temperatures below 2°C shall be immediately surrounded with a heated enclosure. Air temperature within the enclosure shall be maintained between 10°C and 32°C, and the relative humidity shall be above 80 percent. These conditions shall be maintained for a minimum of seven days or for the cure period required by Section 6-02.3(11), whichever is longer. The Contractor shall stop adding moisture 24 hours before removing the heat. Extra protection shall be provided for areas especially vulnerable to freezing (such as exposed top surfaces, corners and edges, thin sections, and concrete placed into steel forms).

If weather forecasts predict air temperatures below 2°C during the seven days just after the concrete placement, the Contractor may place the concrete only if it is protected with a heated enclosure.

6-02.3(6)B Placing Concrete in Foundation Seals

If the Plans require a concrete seal, the Contractor shall place the concrete underwater inside a watertight cofferdam, tube, or caisson. Seal concrete shall be placed in a compact mass in still water. It shall remain undisturbed and in still water until fully set. While seal concrete is being deposited, the water elevation inside and outside the cofferdam shall remain equal to prevent any flow through the seal in either direction. The cofferdam shall be vented at the vent elevation shown in the Plans. The thickness of the seal is based upon this vent elevation.

The seal shall be at least 460 millimeters thick unless the Plans show otherwise. The Engineer may change the seal thickness during construction which may require redesign of the footing and the pier shaft or column. Although seal thickness changes may result in the use of more or less concrete, reinforcing steel, and excavation, payment will remain as originally defined in unit contract prices.

To place seal concrete underwater, the Contractor shall use a concrete pump or tremie. The tremie shall have a hopper at the top that empties into a watertight tube at least 250 millimeters in diameter. The discharge end of the tube on the tremie or concrete pump

shall include a device to seal out water while the tube is first filled with concrete. Tube supports shall permit the discharge end to move freely across the entire work area and to drop rapidly to slow or stop the flow. One tremie may be used to concrete an area up to 5.5 meters per side. Each additional area of this size requires one additional tremie.

Throughout the underwater concrete placement operation, the discharge end of the tube shall remain submerged in the concrete and the tube shall always contain enough concrete to prevent water from entering. The concrete placement shall be continuous until the work is completed, resulting in a seamless, uniform seal. If the concreting operation is interrupted, the Engineer may require the Contractor to prove by core drilling or other tests that the seal contains no voids or horizontal joints. If testing reveals voids or joints, the Contractor shall repair them or replace the seal at no expense to the Contracting Agency.

Concrete Class 28W shall be used for seals, and it shall meet the consistency requirements of Section 6-02.3(4)C.

6-02.3(6)C Dewatering Concrete Seals and Foundations

After a concrete seal is constructed, the Contractor shall pump the water out of the cofferdam and place the rest of the concrete in the dry. This pumping shall not begin until the seal has set enough to withstand the hydrostatic pressure (three days for gravity seals and ten days for seals containing piling or shafts). The Engineer may extend these waiting periods to ensure structural safety or to meet a condition of the operating permit.

If weighted cribs are used to resist hydrostatic pressure at the bottom of the seal, the Contractor shall anchor them to the foundation seal. Any method used (such as dowels or keys) shall transfer the entire mass of the crib to the seal.

No pumping shall be done during or for 24 hours after concrete placement unless done from a suitable sump separated from the concrete work by a watertight wall. Pumping shall be done in a way that rules out any chance of concrete being carried away.

6-02.3(6)D Vacant

6-02.3(7) Concrete Exposed to Sea Water

If sea water will contact a completed concrete structure, the Contractor shall:

1. Mix the concrete for at least 2 minutes.
2. Control water content to produce concrete that will be as impermeable as possible.
3. Compact the concrete as the Engineer may require, avoiding the formation of any stone pockets.
4. Place only clean, rust-free reinforcement bars in the concrete.
5. Coat form surfaces heavily with shellac and any approved form release agent.
6. Leave forms intact for at least 30 days after concrete placement (longer if the Engineer requires) to prevent sea water from contacting the concrete.
7. Leave the surface of concrete just as it comes from the forms.
8. Provide special handling for any concrete piles used in sea water to avoid even slight deformation cracks.

The Engineer shall decide the range of disintegration possible by exposure to sea water. This range shall extend from a point below the level of extreme low tide up to a point above the level of extreme high tide. Wave action and other conditions will also affect the Engineer's decision on this range. Unless the Engineer approves otherwise, the Contractor shall not locate construction joints within this range. All concrete within this range shall be poured in the dry.

6-02.3(8) Concrete Exposed to Alkaline Soils or Water

The requirements for concrete in sea water shall also apply to concrete in alkaline soils or water. In addition, the Contractor shall:

1. Let the concrete set at least 30 days (longer if possible) before allowing soil or water to contact it directly;
2. Vibrate each batch of concrete immediately after it has been placed into the forms, using enough vibrating tampers to do this effectively; and
3. Hand tamp, if necessary, to produce smooth, dense outside surfaces.

6-02.3(9) Vibration of Concrete

The Contractor shall supply enough vibrators to consolidate the concrete (except that placed underwater) according to the requirements of this section. Each vibrator must:

1. Be designed to operate while submerged in the concrete,
2. Vibrate at a rate of at least 7,000 pulses per minute, and
3. Receive the Engineer's approval on its type and method of use.

Immediately after concrete is placed, vibration shall be applied in the fresh batch at the point of deposit. In doing so, the Contractor shall:

1. Space the vibrators evenly, no farther apart than twice the radius of the visible effects of the vibration;
2. Ensure that vibration intensity is great enough to visibly affect a mass of 25 millimeters slump concrete across a radius of at least 460 millimeters;
3. Insert the vibrators slowly to a depth that will effectively vibrate the full depth of each layer, penetrating into the previous layer on multilayer pours;
4. Protect partially hardened concrete (i.e., nonplastic, which prevents vibrator penetration when only its own mass is applied) by preventing the vibrator from penetrating it or making direct contact with steel that extends into it;
5. Not allow vibration to continue in one place long enough to form pools of grout;
6. Continue vibration long enough to consolidate the concrete thoroughly, but not so long as to segregate it;
7. Withdraw the vibrators slowly when the process is complete; and
8. Not use vibrators to move concrete from one point to another in the forms.

When vibrating and finishing top surfaces that will be exposed to weather or wear, the Contractor shall not draw water or laitance to the surface. In high lifts, the top layer shall be shallow and made up of a concrete mix as stiff as can be effectively vibrated and finished.

To produce a smooth, dense finish on outside surfaces, the Contractor shall hand tamp the concrete.

6-02.3(10) Roadway Slabs

A preconcreting conference shall be held five to ten working days before placing concrete to discuss construction procedures, personnel, and equipment to be used. Those attending shall include:

1. (representing the Contractor) The superintendent and all foremen in charge of placing steel reinforcing bars, of placing the concrete, and of finishing it; and
2. (representing the State) The Project Engineer and key inspection assistants.

If the project includes more than one slab, and if the Contractor's key personnel change between concreting operations, an additional conference shall be held just before each slab is placed.

The Contractor shall not place roadway slabs until the Engineer agrees that:

1. Concrete producing and placement rates will be high enough to meet placing and finishing deadlines,
2. Finishers with enough experience have been employed, and
3. Adequate finishing tools and equipment are at the site.

The finishing machine shall be self-propelled and be capable of forward and reverse movement under positive control. The finishing machine shall be equipped with a rotating cylindrical single or double drum screed not exceeding 1.5 meters in length. The finishing machine shall have the necessary adjustments to produce the required cross-section, line, and grade. Provisions shall be made for the raising and lowering of all screeds under positive control. The upper vertical limit of screed travel shall permit the screed to clear the finished concrete surface. When placing concrete abutting a previously placed slab, the side of the finishing machine adjacent to the existing slab shall be equipped to travel on the existing slab.

The Contractor may use hand-operated strike-boards only when the Engineer approves for special conditions and small areas (less than 3 meters in width and 60 meters in length). These boards must be sturdy and able to strike off the full placement width without intermediate supports. Strike-boards, screed rails, and any specially made auxiliary equipment shall receive the Engineer's approval before use. All finishing requirements in these specifications apply to hand-operated finishing equipment.

Screed rails shall rest on adjustable supports that can be removed with the least possible disturbance to the screeded concrete. The supports shall rest on structural members or on forms rigid enough to resist deflection. Supports shall be removable to at least 50 millimeters below the finished surface. If possible, the Contractor shall place screed rails outside the finishing area. But if they are placed inside the area, they shall be placed above the finished surface.

Screed rails (with their supports) shall be strong enough and stiff enough to permit the finishing machine to operate effectively on them. All screed rails shall be placed and secured for the full length of the slab before the concreting begins. If the Engineer approves in advance, the Contractor may move rails ahead onto previously set supports while concreting progresses. But such movable rails and their supports shall not change the set elevation of the screed.

On steel truss and girder spans, screed rails and bulkheads may be placed directly on transverse steel floorbeams, with the strike-board moving at right angles to the centerline of the roadway.

Before any concrete is placed, the finishing machine shall be operated over the entire length of the slab to check screed deflection. Concrete placement may begin only if the Engineer approves after this test.

Immediately before placing concrete, the Contractor shall check (and adjust if necessary) all falsework and wedges to minimize settlement and deflection from the added mass of the concrete slab. The Contractor shall also install devices, such as telltales, by which the Engineer can readily measure settlement and deflection.

The Contractor shall schedule the concrete placement so that it can be completely finished during daylight. After dark finishing is permitted if the Engineer approves and if the Contractor provides adequate lighting.

The placement operation shall cover the full width of the roadway or the full width between construction joints. The Contractor shall locate any construction joint over a beam or web that can support the slab on either side of the joint. The joint shall not occur over

a pier unless the Plans permit. Each joint shall be formed vertically and in true alignment. The Contractor shall not release falsework or wedges supporting pours on either side of a joint until each side has aged as these Specifications require.

Placement of concrete for slabs shall comply with Section 6-02.3(6). The Engineer shall approve the placement method. In placing the concrete, the Contractor shall:

1. Place it (without segregation) against concrete placed earlier, as near as possible to its final position, approximately to grade, and in shallow, closely spaced piles;
2. Consolidate it around reinforcing steel by using vibrators before strike-off by the finishing machine;
3. Not use vibrators to move concrete;
4. Not revibrate any concrete surface areas where workers have stopped prior to screeding;
5. Remove any concrete splashed onto reinforcing steel in adjacent segments before concreting them;
6. Tamp and strike off the concrete with a template or strike-board moving slowly forward at an even speed;
7. Maintain a slight excess of concrete in front of the cutting edge across the entire width of the placement operation;
8. Make enough passes with the strike-board (without bringing excessive amounts of mortar to the surface) to create a surface that is true and ready for final finish; and
9. Leave a thin, even film of mortar on the concrete surface after the last pass of the strike-board.

Workers shall complete all post screeding operations without walking on the concrete. This may require work bridges spanning the full width of the slab.

After removing the screed supports, the Contractor shall fill the voids with concrete (not mortar).

If necessary, as determined by the Engineer, the Contractor shall float the surface left by the finishing machine to remove roughness, minor irregularities, and seal the surface of the concrete. Floating shall leave a smooth and even surface. The floats shall be at least 1.2 meters long. Each transverse pass of the float shall overlap the previous pass by at least half the length of the float. The first floating shall be at right angles to the strike-off. The second floating shall be at right angles to the centerline of the span. A smooth riding surface shall be maintained across construction joints.

Expansion joints shall be finished with a 13 millimeters radius edger.

After floating, but while the concrete remains plastic, the Contractor shall test the entire slab for flatness (allowing for crown, camber, and vertical curvature). The testing shall be done with a 3-meter straightedge held on the surface. The straightedge shall be advanced in successive positions parallel to the centerline, moving not more than one half the length of the straightedge each time it advances. This procedure shall be repeated with the straightedge held perpendicular to the centerline. An acceptable surface shall be one free from deviations of more than 3 millimeters under the 3-meter straightedge.

If the test reveals depressions, the Contractor shall fill them with freshly mixed concrete, strike off, consolidate, and refinish them. High areas shall be cut down and refinished. Retesting and refinishing shall continue until an acceptable, deviation free surface is produced. The hardened concrete shall meet all smoothness requirements of these Specifications even though the tests require corrective work.

The Contractor will texture the bridge deck by combing the final surface perpendicular to the centerline. Made of a single row of metal tines, the comb shall leave striations in the fresh concrete approximately 5 millimeters deep by 3 millimeters wide and spaced approximately 13 millimeters apart. The Engineer will decide actual depths at the site. (If the comb has not been approved, the Contractor shall obtain the Engineer's approval by demonstrating it on a test section.)

The Contractor may operate the combs manually or mechanically, either singly or with several placed end to end. The timing and method used shall produce the required texture without displacing larger particles of aggregate. Texturing shall end 0.6 meter from curb lines. This 0.6-meter untextured strip shall be hand finished with a steel trowel.

If the Plans call for an overlay (to be constructed under the same contract), such as asphalt concrete, latex modified concrete, epoxy concrete, or similar, the Contractor shall produce the final finish by dragging a strip of damp, seamless burlap lengthwise over the full width of the slab or by brooming it lightly. A burlap drag shall equal the slab in width. Approximately 1 meter of the drag shall contact the surface, with the least possible bow in its leading edge. It must be kept wet and free of hardened lumps of concrete. When it fails to produce the required finish, the Contractor shall replace it. When not in use, it shall be lifted clear of the slab.

After the slab has cured, the surface shall not vary more than 3 millimeters under a 3-meter straightedge placed parallel and perpendicular to the centerline.

The Contractor shall cut high spots down with a diamond faced, saw-type cutting machine. This machine shall cut through mortar and aggregate without breaking or dislodging the aggregate or causing spalls.

Low spots shall be built up utilizing a grout or concrete with a strength equal to or greater than the required 28-day strength of the roadway slab. The method of build-up shall be submitted to the Engineer for approval.

The surface texture on any area cut down or built up shall match closely that of the surrounding deck. The entire bridge roadway slab must provide a smooth riding surface.

Concrete for sidewalk slabs shall be well compacted, struck off with a strike-board, and floated with a wooden float to achieve a surface that does not vary more than 3 millimeters under a 3-meter straightedge. An edging tool shall be used to finish all sidewalk edges and expansion joints. The final surface shall have a granular texture that will not turn slick when wet.

6-02.3(11) Curing Concrete

After placement, concrete surfaces shall be cured as follows:

1. Bridge roadway slabs (except those made of concrete Class 28D), flat slab bridge superstructures, bridge sidewalks, box culvert tops, roofs of cut and cover tunnels — curing compound covered by white, reflective type sheeting or continuous wet curing for at least 10 days.
2. Class 28D concrete (regardless of structure type) — two coats of curing compound and continuous wet cure using heavy quilted blankets or burlap for 14 days.
3. Retaining walls, culvert sidewalls, and culvert floors — continuous moisture for at least ten days.
4. All other concrete surfaces (except traffic barriers and rail bases) — continuous moisture for at least three days.

The Contractor may provide continuous moisture by watering a covering of heavy quilted blankets, by watering and covering with a white reflective type sheeting, or by wetting the outside surfaces of wood forms. Runoff water shall be collected and disposed of in accordance with all applicable regulations. In no case shall runoff water be allowed to enter any lakes, streams, or other surface waters.

When curing Class 28D, two coats of curing compound that complies with Section 9-23.2 shall be applied immediately after finishing or as soon as the visible bleed water has evaporated. The surface shall be covered with presoaked heavy quilted blankets or burlap as soon as the concrete has set enough to allow covering without damaging the finish.

For all other concrete requiring curing compound, the Contractor shall apply two coats (that complies with Section 9-23.2) to the fresh concrete. The compound shall be applied immediately after finishing as soon as the visible bleed water has evaporated or as soon as the Engineer directs. Application of the second coat shall run at right angles to that of the first. The two coats shall total at least 1 liter per 3.7 square meters and shall obscure the original color of the concrete. If any curing compound spills on construction joints or reinforcing steel, the Contractor shall clean it off before the next pour.

If the Plans call for an asphalt overlay, the Contractor shall use the clear curing compound (Type 1D), applying at least 1 liter per 3.7 square meters to the concrete slab. Otherwise, the Contractor shall use white pigmented curing compound (Type 2), agitating it thoroughly just before and during application. If other materials are to be bonded to the surface, the Contractor shall remove the curing compound by sandblasting or acceptable high pressure water washing.

The Contractor shall have on the site, back-up spray equipment, enough workers, and a bridge from which they will apply the curing compound. The Engineer may require the Contractor to demonstrate (at least one day before the pour) that the crew and equipment can apply the compound acceptably.

No later than the morning after applying the curing compound, the Contractor shall cover the top surfaces with white, reflective sheeting, leaving it in place for at least ten days. Throughout this period, the sheeting shall be kept in place by taping or weighting the edges where they overlap.

The unit contract prices shall cover all concrete curing costs.

6-02.3(11)A Curing and Finishing Concrete Traffic and Pedestrian Barrier

The Contractor shall supply enough water and workers to cure and finish concrete barrier as required in this section. Unit contract prices shall cover all curing and finishing costs.

Fixed-Form Barrier

The edge champfers shall be formed by attaching champfer strips to the barrier forms.

After troweling and edging a barrier (while the forms remain in place), the Contractor shall:

1. Brush the top surface with a fine bristle brush;
2. Cover the top surface with heavy, quilted blankets; and
3. Spray water on the blankets and forms at intervals short enough to keep them thoroughly wet for three days.

After removing the forms, the Contractor shall:

1. Remove all lips and edgings with sharp tools or chisels;
2. Fill all holes with mortar;
3. True up corners of openings;
4. Remove concrete projecting beyond the true surface by stoning or grinding;
5. Cover the barrier with heavy, quilted blankets (not burlap);

6. Keep the blankets continuously wet for at least seven days.

The Contractor may do the finishing work described in steps 1 through 4 above during the second (the seven day) curing period if the entire barrier is kept covered except the immediate work area. Otherwise, no finishing work may be done until at least ten days after pouring.

After the ten day curing period, the Contractor shall remove from the barrier all form-release agent, mud, dust, and other foreign substances in either of two ways: (1) by light sandblasting and washing with water, or (2) by spraying with a high-pressure water jet. The water jet equipment shall use clean fresh water and shall produce (at the nozzle) at least 10 megapascals with a discharge of at least 0.2 liters per second. The water jet nozzle shall have a 25 degree tip and shall be held no more than 230 millimeters from the surface being washed.

After cleaning, the Contractor shall use brushes to rub 1:1 mortar into air holes and small crevices on all surfaces except the brushed top. This mortar shall consist of one part Portland cement (of the same brand used in the concrete) and one part clean, fine plaster sand. As soon as the mortar takes its initial set, the Contractor shall rub it off with a piece of sacking or carpet. The barrier shall then be covered with wet blankets for at least 48 hours.

No curing compound shall be used on fixed-form concrete barrier. The completed surface of the concrete shall be even in color and texture.

Slip-Form Barrier

The edge radius shall be formed by attaching radius strips to the barrier slip form.

The Contractor shall finish slip-form barrier by: (1) steel troweling to close all surface pockmarks and holes; and (2) for plain surface barrier, lightly brushing the front and back face with vertical strokes and the top surface with transverse strokes.

After finishing, the Contractor shall cure the slip-form barrier by using either method A (curing compound) or B (wet blankets) described below.

Method A. Under the curing compound method, the Contractor shall:

1. Spray two coats of clear curing compound (Type 1D) on the concrete surface after the free water has disappeared. (Coverage of combined coats shall equal at least 1 liter per 3.7 square meter.)
2. No later than the morning after applying the curing compound, cover the barrier with white, reflective sheeting for at least ten days.
3. After the ten day curing period, remove the curing compound as necessary by light sandblasting or by spraying with a high-pressure water jet to produce an even surface appearance. The water jet equipment shall use clean fresh water and shall produce (at the nozzle) at least 17 megapascals with a discharge of at least 0.25 liter per second. The water jet nozzle shall have a 25-degree tip and shall be held no more than 230 millimeters from the surface being cleaned. The Contractor may propose to use a curing compound/concrete sealer. The Engineer will evaluate the proposal and if found acceptable, shall approve the proposal in writing. As a minimum, the Contractor's proposal shall include:

   Product identity
   Manufacturer's recommended application rate
   Method of application and necessary equipment
   Material Safety Data Sheet (MSDS)
   Sample of the material for testing

   Allow 14 working days for evaluating the proposal and testing the material.

Method B. Under the wet cure method, the Contractor shall:

1. Provide an initial cure period by continuous fogging or mist spraying for at least the first 24 hours.
2. After the initial cure period, cover the barrier with a heavy quilted blanket.
3. Keep the blankets continuously wet for at least ten days. (No additional finishing is required at the end of the curing period.)

6-02.3(12) Construction Joints

If the Engineer approves, the Contractor may add, delete, or relocate construction joints shown in the Plans. Any request for such changes shall be in writing, accompanied by a drawing that depicts them. The Contractor will bear any added costs that result from such changes.

All construction joints shall be formed neatly with grade strips or other approved methods. The Contracting Agency will not accept irregular or wavy pour lines. Wire mesh forming material shall not be used. All joints shall be horizontal, vertical, or perpendicular to the main reinforcement. The Contractor shall not use an edger on any construction joint, and shall remove any lip or edging before making the adjacent pour.

If the Plans require a roughened surface on the joint, the Contractor shall strike it off to leave grooves at right angles to the length of the member. The grooves shall be 13 millimeters to 25 millimeters wide, 6 millimeters to 13 millimeters deep, and spaced equally at twice the width of the groove. If the first strike-off does not produce the required roughness, the Contractor shall repeat the process before the concrete reaches initial set. The final surface shall be clean and without laitance or loose material.

If the Plans do not require a roughened surface, the Contractor shall include shear keys at all construction joints. These keys shall provide a positive, mechanical bond. Shear keys shall be formed depressions and the forms shall not be removed until the concrete has been in place at least 12 hours. Forms shall be slightly beveled to ensure ready removal. Raised shear keys are not allowed.

Shear keys for the tops of beams, at tops and bottoms of boxed girder webs, in diaphragms, and in crossbeams shall:

1. Be formed with 50- by 200-millimeter wood blocks;
2. Measure 200 millimeters lengthwise along the beam or girder stem;
3. Measure 100 millimeters less than the width of the stem, beam, crossbeam, etc. (measured transverse of the stem); and
4. Be spaced at 400 millimeters center to center.

Unless the Plans show otherwise, in other locations (not named above), shear keys shall equal approximately one third of the joint area and shall be approximately 38 millimeters deep.

Before placing new concrete against cured concrete, the Contractor shall thoroughly clean and roughen the cured face and wet it with water. Before placing the reinforcing mat for footings on seals, the Contractor shall: (1) remove all scum, laitance, and loose gravel and sediment; (2) clean the construction joint at the top of the seals; and (3) chip off any high spots on the seals that would prevent the footing steel from being placed in the position required by the Plans.

6-02.3(13) Expansion Joints

This section outlines the requirements of specific expansion joints shown in the Plans. The Plans may require other types of joints, seals, or materials than those described here.

Joints made of a vulcanized, elastomeric compound (with neoprene as the only polymer) shall be installed with an approved lubricant adhesive as recommended by the manufacturer. The length of a seal shall match that required in the Plans without splicing or stretching.

Open joints shall be formed with a template made of wood, metal, or other suitable material. Insertion and removal of the template shall be done without chipping or breaking the edges or otherwise injuring the concrete.

Any part of an expansion joint running parallel to the direction of expansion shall provide a clearance of at least 13 millimeters (produced by inserting and removing a spacer strip) between the two surfaces. The Contractor shall ensure that the surfaces are precisely parallel to prevent any wedging from expansion and contraction.

All poured rubber joint sealer (and any required primer) shall conform with Section 9-04.2(2).

6-02.3(14) Finishing Concrete Surfaces

All concrete shall show a smooth, dense, uniform surface after the forms are removed. If it is porous, the Contractor shall bear the cost of repairing it. The Contractor shall clean and refinish any stained or discolored surfaces that may have resulted from their work or from construction delays.

Subsections A and B (below) describe two classes of surface finishing.

6-02.3(14)A Class 1 Surface Finish

The Contractor shall apply a Class 1 finish to all surfaces of concrete members to the limits designated in the contract plans.

The Contractor shall follow steps 1 through 8 below. When steel forms have been used and when the surface of filled holes matches the texture and color of the area around them, the Contractor may omit steps 3 through 8. To create a Class 1 surface, the Contractor shall:

1. Remove all bolts and all lips and edgings where form members have met;
2. Fill all holes greater than 6 millimeters with 1:2 mortar floated to an even, uniform finish;
3. Thoroughly wash the surface of the concrete with water;
4. Brush on a 1:1 mortar, working it well into the small air holes and other crevices in the face of the concrete;
5. Brush on no more mortar than can be finished in one day;
6. Rub the mortar off with burlap or a piece of carpet as soon as it takes initial set (before it reaches final set);
7. Fog-spray water over the finish as soon as the mortar paint has reached final set; and
8. Keep the surface damp for at least two days.

If the mortar becomes too hard to rub off as described in step 6, the Contractor shall remove it with a Carborundum stone and water. Random grinding is not permitted.

6-02.3(14)B Class 2 Surface Finish

The Contractor shall apply a Class 2 finish to all above=ground surfaces not receiving a Class 1 finish as specified above. Surfaces covered with fill do not require a surface finish.

To produce a Class 2 finish, the Contractor shall remove all bolts and all lips and edgings where form members have met and fill all form tie holes.

6-02.3(14)C Vacant

6-02.3(15) Date Numerals

Standard date numerals shall be placed where shown in the Plans. The date shall be for the year in which the structure is completed. When traffic barrier is placed on an existing structure, the date shall be for the year in which the original structure was completed. Unit contract prices shall cover all costs relating to these numerals.

6-02.3(16) Plans for Falsework and Formwork

The Contractor shall submit all plans for falsework and formwork for approval or preapproval directly to the Bridge and Structures Office, Construction Support Engineer, Washington State Department of Transportation, PO Box 47340, Olympia, WA 98504-7340 as described in Section 6-02.3(16)A or 6-02.3(16)B. The Contractor shall also submit two sets of the falsework and formwork plans to the Project Engineer. Approval will not reduce the Contractor's responsibility for ensuring the adequacy of the formwork and falsework. All falsework and formwork shall be constructed in accordance with approved falsework and formwork plans.

Except for the placement of falsework foundation pads and piles, the construction of any unit of falsework shall not start until the Engineer has reviewed and approved the falsework plans for that unit. Falsework driven piling, temporary concrete footings, or timber mudsills may be placed as described in Section 6-02.3(17)D prior to approval at the Contractor's own risk, except for the following conditions:

1. The falsework is over or adjacent to roadways or railroads as described in Section 6-02.3(17)C, or
2. The falsework requires prior placement of shoring or cofferdams as described in Section 2-09.3(3)D.

Costs associated with modifying falsework to bring it into compliance with the approved falsework plans shall be at the Contractor's expense.

If the project involves a railroad or the U.S. Bureau of Reclamation, additional sets for the portion of the project that involves them shall be sent to:

US Postal Service:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340

Fedex:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

1. Four sets for each railroad company affected, and
2. Six sets for the U.S. Bureau of Reclamation.

The Department will review the falsework and formwork plans and calculations, and if they are acceptable, will obtain the required approvals from the appropriate railroad company or the U.S. Bureau of Reclamation. After the Department has received approval

and any comments from the railroad company or the U.S. Bureau of Reclamation, two copies of the falsework and formwork plans will then be marked with any comments and returned to the Contractor.

Plan approval is not required for footing or retaining walls unless they are more than 1.2 meters high (excluding pedestal height).

The design of falsework and formwork shall be based on:

1. Applied loads and conditions which are no less severe than those described in Section 6-02.3(17)A, "Design Loads;"
2. Allowable stresses and deflections which are no greater than those described in Section 6-02.3(17)B, "Allowable Stresses and Deflections;"
3. Special loads and requirements no less severe than those described in Section 6-02.3(17)C, "Falsework and Formwork at Special Locations;" and
4. Conditions required by other Sections of 6-02.3(17), "Falsework and Formwork."

Plan approval can be done by the Project Engineer for footings and walls 1.2 meters to 2.4 meters high (excluding pedestal height) provided:

1. Concrete placement rate is 1.2 meters per hour or less.
2. Facing is 19-millimeter plywood with grade as specified per Section 6-02.3(17)J.
3. Studs, with plywood face grain perpendicular, are 2 × 4's spaced at 300 millimeters.
4. Walers with 13.3 kiloNewton safe working load ties spaced at 600 millimeters, are two 2 × 4's spaced at 600 millimeters.

Plan approval can be done by the Project Engineer for manufactured certified steel round column forming for column heights up to 6 meters. Concrete placement rate shall not exceed 3 meters per hour. Bracing requirements shall be per manufacturer's recommendations or submitted according to Section 6-02.3(16).

The falsework and formwork plans shall be scale drawings showing the details of proposed construction, including: sizes and properties of all members and components; spacing of bents, posts, studs, wales, stringers, wedges and bracing; rates of concrete placement, placement sequence, direction of placement, and location of construction joints; identify falsework devices and safe working load as well as identifying any bolts or threaded rods used with the devices including their diameter, length, type, grade, and required torque. Show in the falsework plans the proximity of falsework to utilities or any nearby structures including underground structures. Formwork accessories shall be identified according to Section 6-02.3(17)H, "Formwork Accessories." All assumptions, dimensions, material properties, and other data used in making the structural analysis shall be noted on the drawing.

The Contractor shall furnish two copies of the associated design calculations to the Bridge and Structures Office, Construction Support Engineer for examination as a condition for approval. The design calculations shall show the stresses and deflections in load supporting members. Construction details which may be shown in the form of sketches on the calculation sheets shall be shown in the falsework or formwork drawings as well. Falsework or formwork plans will not be approved in any case where it is necessary to refer to the calculation sheets for information needed for complete understanding of the falsework and formwork plans or how to construct the falsework and formwork.

All falsework and formwork plans and design calculations submitted to the Bridge and Structures Office shall be prepared by (or under the direct supervision of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural Engineering.

Each sheet of falsework and formwork plans shall carry the following:

1. Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration.
2. The initials and dates of all participating design professionals.
3. Clear notation of all revisions including identification of who authorized the revision, who made the revision, and the date of the revision.
4. The contract number, contract title, and sequential sheet number. These shall also be on any related documents.
5. Identify where the falsework and formwork plan will be utilized by referencing Contract Plan sheet number and related item or detail.

Design calculations shall carry on the cover page, the Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration. The cover page shall include the contract number, contract title, and sequential index to calculation page numbers.

A State of Washington Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural Engineering may be retained to check, review and certify falsework and formwork plans and calculations of an individual who is licensed in another state provided that the following conditions are satisfied:

1. That the work being reviewed was legally prepared by an individual holding valid registration in another state as a civil or structural engineer.
2. The Washington State Professional Engineer conducts independent calculations and reviews all technical matters contained within the subject work, falsework and formwork plans, Contract Plans, Specifications, legal requirements, technical standards, other related documents; and has verified that the design meets all applicable specifications and is in agreement with the specific site conditions and geometry.
3. All falsework and formwork plan sheets shall carry the Washington State Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration.
4. Two copies of the Washington State Professional Engineer's independent calculations shall be submitted to the Bridge and Structures Office, Construction Support Engineer for review along with the falsework and formwork plans. The independent calculations shall carry on the cover page the Washington State Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration. The cover page shall include the following: the contract number, contract title, and sequential index to calculation page numbers
5. The Washington State Professional Engineer shall keep, a signed and sealed copy of the falsework, formwork plans, independent calculations, specifications and other related documentation that represents the extent of the review.

6-02.3(16)A Nonpreapproved Falsework and Formwork Plans

The Contractor shall submit six copies of all non-preapproved falsework and formwork plans, and two copies of the design calculations, directly to the following for review and approval and submit two copies of the falsework and formwork plans to the Project Engineer.

US Postal Service:
Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340
Fedex:
Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

Reviewed falsework and formwork plans will be returned from the Bridge and Structures Office, Construction Support Engineer, to the Project Engineer who will forward them to the Contractor within the time allowed according to Section 6-01.9. The time allowed begins when the Contractor's transmittal and submittal including all required copies of the falsework and/or formwork plans and calculations, catalog data, and other technical information are received by the Bridge and Structures Office, Construction Support Engineer. Fax copies are considered only informational. For multiple submittals or multiple parts to the same submittal and priority of review see Section 6-01.9.

Plans returned to the Contractor for correction shall be corrected and clean (without any previous WSDOT stamps and comments) revised falsework and formwork plans resubmitted to the Bridge and Structures Office, Construction Support Engineer for review and approval.

The Contractor may revise approved falsework and formwork plans, provided sufficient time is allowed for the Engineer's review and approval before construction is started on the revised portions. Such additional time will not be more than that which was originally allowed per Section 6-01.9. After a plan or drawing is approved and returned to the Contractor, all changes that the Contractor proposed shall be submitted to the Project Engineer for review and approval.

6-02.3(16)B Preapproved Formwork Plans

The Contractor may request preapproval on formwork plans for abutments, wingwalls, diaphragms, retaining walls, columns, girders and beams, box culverts, railings, and bulkheads. Plans for falsework supporting the roadway slab for interior spans between precast prestressed concrete girders may also be submitted for preapproval. Other falsework plans, however, will not be preapproved, but shall be submitted for review and approval as required in Section 6-02.3(16)A.

To apply for preapproval, the Contractor shall submit one reproducible drawing for each formwork plan sheet and two copies of the design calculations directly to:

US Postal Service:
Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340

Fedex:
Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

The Bridge and Structures Office, Construction Support Engineer will return the formwork plan to the Contractor stamped "Preapproved" with an effective date of approval or will indicate any changes required for approval. The reviewed formwork plan will be returned from the Bridge and Structures Office, Construction Support Engineer to the Contractor within the time allowed according to Section 6-01.9. The time allowed begins when the Contractor's transmittal and submittal including all required information are received by the Bridge and Structures Office, Construction Support Engineer.

For each contract on which the preapproved formwork plans will be used, the Contractor shall submit three copies to the Project Engineer. Construction shall not begin until the Project Engineer has given approval.

If the forms being constructed have any deviations to the preapproved formwork plan, the Contractor shall submit formwork plan revisions for review and approval per Section 6-02.3(16)A.

Preapproved formwork plans and calculations approved prior to January 1, 1994 shall be resubmitted for review and approval using the current design loads, allowable stresses and specifications.

6-02.3(17) Falsework and Formwork

Formwork and falsework are both structural systems. Formwork contains the lateral pressure exerted by concrete placed in the forms. Falsework supports the vertical and/or the horizontal loads of the formwork, reinforcing steel, concrete, and live loads during construction.

The Contractor shall set falsework, to produce in the finished structure, the lines and grades indicated in the Contract Plans. The setting of falsework shall allow for shrinkage, settlement, falsework girder camber, and any structural camber the Plans or the Engineer require.

Concrete forms shall be mortar tight, true to the dimensions, lines, and grades of the structure. Curved surfaces shown in the Contract Plans shall be constructed as curved surfaces and not chorded, except as allowed in Section 6-02.3(17)J. Concrete formwork shall be of sufficient strength and stiffness to prevent overstress and excess deflection as defined in Section 6-02.3(17)B. The rate of depositing concrete in the forms shall not exceed the placement rate in the approved formwork plan. The interior form shape and dimensions shall also ensure that the finished concrete will conform with the Contract Plans.

If the new structure is near or part of an existing one, the Contractor shall not use the existing structure to suspend or support falsework unless the Plans or Special Provisions state otherwise. For prestress girder and T-beam bridge widenings or stage construction, the roadway deck and the diaphragm forms may be supported from the existing structure or previous stage, if approved by the Engineer. For steel plate girder bridge widenings or stage construction, only the roadway deck forms may be supported from the existing structure or previous stage, if approved by the Engineer. See Section 6-02.3(17)E for additional conditions.

On bridge roadway slabs, forms designed to stay in place made of steel or precast concrete panels shall not be used.

For post-tensioned structures, both falsework and forms shall be designed to carry the additional loads caused by the post-tensioning operations. The Contractor shall construct supporting falsework in a way that leaves the superstructure free to contract and lift off the falsework during post-tensioning. Forms that will remain inside box girders to support the placement of the roadway slab concrete shall, by design, resist girder contraction as little as possible. See Section 6-02.3(26) for additional conditions.

6-02.3(17)A Design Loads

The design load for falsework shall consist of the sum of dead and live vertical loads, and a design horizontal load. The minimum total design load for any falsework shall not be less than 4.8 kilopascals for combined live and dead load regardless of structure thickness.

The entire superstructure cross-section, except traffic barrier, shall be considered to be placed at one time for purposes of determining support requirements and designing falsework girders for their stresses and deflections, except as follows:

For concrete box girder bridges, the girder stems, diaphrams, crossbeams, and connected bottom slabs, if the stem wall is placed more than 5 days prior to the top slab, may be considered to be self supporting between falsework bents at the time the top slab is placed, provided that the distance between falsework bents does not exceed 4 times the depth of the portion of the girder placed in the preceding concrete placements.

Falsework bents shall be designed for the entire live load and dead load, including all load transfer that takes place during post-tensioning, and braced for the design horizontal load.

Dead loads shall include the mass of all successive placements of concrete, reinforcing steel, forms and falsework, and all load transfer that takes place during post-tensioning. The mass of concrete with reinforcing steel shall be assumed to be not less than 2600 kilograms per cubic meter.

Live loads shall consist of the actual mass of any equipment to be supported by falsework applied as concentrated loads at the points of contact, and a minimum uniform load of not less than 1.2 kilopascals applied over the entire falsework plan area supported, plus a minimum load of not less than 110 kilograms per meter applied at the outside edge of deck overhangs.

The design horizontal load to be resisted by the falsework bracing system in any direction shall be:

The sum of all identifiable horizontal loads due to equipment, construction sequence, sidesway caused by geometry or eccentric loading conditions, or other causes, and an allowance for wind plus an additional allowance of 1 percent of the total dead load to provide for unexpected forces. In no case shall the design horizontal load be less than three percent of the total dead load.

The minimum horizontal load to be allowed for wind on each heavy-duty steel shoring tower having a vertical load carrying capacity exceeding 130 kiloNewton per leg shall be the sum of the products of the wind impact area, shape factor, and the applicable wind pressure value for each height zone. The wind impact area is the total projected area of all the elements in the tower face normal to the applied wind. The shape factor for heavy-duty steel shoring towers shall be taken as 2.2. Wind pressure values shall be determined from the following table:

Wind Pressure on Heavy-Duty Steel Shoring Towers

Height Zone (Meters Above Ground)	Wind Pressure Value: Adjacent to Traffic	Wind Pressure Value: At Other Locations
0 to 9	1.0 kPa	0.7 kPa
9 to 15	1.2 kPa	1.0 kPa
15 to 30	1.4 kPa	1.2 kPa
Over 30	1.7 kPa	1.4 kPa

The minimum horizontal load to be allowed for wind on all other types of falsework, including falsework girders and forms supported on heavy-duty steel shoring towers, shall be the sum of the products of the wind impact area and the applicable wind pressure value for each height zone. The wind impact area is the gross projected area of the falsework support system, falsework girders, forms and any unrestrained portion of the permanent structure, excluding the areas between falsework posts or towers where diagonal bracing is not used. Wind pressure values shall be determined from the following table:

Wind Pressure on All Other Types of Falsework

Height Zone (Meters Above Ground)	Wind Pressure Value: For Members Over and Bents Adjacent to Traffic Openings	Wind Pressure Value: At Other Locations
0 to 9	96 Q Pa	72 Q Pa
9 to 15	120 Q Pa	96 Q Pa
15 to 30	144 Q Pa	120 Q Pa
Over 30	168 Q Pa	144 Q Pa

The value of Q in the above tabulation shall be determined as follows:

$Q = 0.3 + 0.2W$; but Q shall not be more than –3.

Where:

W is the width of the falsework system, in meters, measured normal to the direction of the wind force being considered.

The falsework system shall also be designed so that it will be sufficiently stable to resist overturning prior to the placement of the concrete. The minimum factor of safety against falsework overturning in all directions from the assumed horizontal load for all stages of construction shall be 1.25. If the required resisting moment is less than 1.25 times the overturning moment, the difference shall be resisted by bracing, cable guys, or other means of external support.

Design of falsework shall include the vertical component (whether positive or negative) of bracing loads imposed by the design horizontal load. Design of falsework shall investigate the effects of any horizontal displacement due to stretch of the bracing. This is particularly important when using cable or rod bracing systems.

If the concrete is to be post-tensioned, the falsework shall be designed to support any increased or redistributed loads caused by the prestressing forces.

6-02.3(17)B Allowable Design Stresses and Deflections

The maximum allowable stresses listed in this Section are based on the use of identifiable, undamaged, high-quality materials. Stresses shall be appropriately reduced if lesser quality materials are to be used.

These maximum allowable stresses include all adjustment factors, such as the short term load duration factor. The maximum allowable stresses and deflections used in the design of the falsework and formwork shall be as follows:

Deflection:

Deflection resulting from dead load and concrete pressure for exposed visible surfaces, 1/360 of the span.

Deflection resulting from dead load and concrete pressure for unexposed non-visible surfaces, including the bottom of the deck slab between girders, 1/270 of the span.

In the foregoing, the span length shall be the center line to center line distance between supports for simple and continuous spans, and from the center line of support to the end of the member for cantilever spans. For plywood supported on members wider than 38 millimeters, the span length shall be taken as the clear span plus 38 millimeters. Also, dead load shall include the mass of all successive placements of concrete, reinforcing steel, forms and falsework self mass. Only the self mass of falsework girders may be excluded from the calculation of the above deflections provided that the falsework girder deflection is compensated for by the installation of camber strips.

Where successive placements of concrete are to act compositely in the completed structure, deflection control becomes extremely critical. Maximum deflection of supporting members –1/500 of the span for members constructed in several successive placements, (such as concrete box girder and concrete T-beam girder structures), falsework components shall be sized, positioned, and/or supported to minimize progressive increases in deflection of the structure which would preload the concrete or reinforcing steel before it becomes fully composite.

Timber:

Each species and grade of timber/lumber used in constructing falsework and formwork shall be identified in the drawings. The allowable stresses and loads shall not exceed the lesser of stresses and loads given in the table below or factored stresses for designated species and grade in Table 7.3 of the *Timber Construction Manual, Third Edition* by the American Institute of Timber Construction.

Compression perpendicular to the grain reduced to 2 MPa for use when moisture content is 19 percent or more (areas exposed to rain, concrete curing water, green lumber).	3 MPa
Compression parallel to the grain but not to exceed 10 MPa.	$\frac{3300\ \text{MPa}}{(L/d)^2}$
Flexural stress for members with a nominal depth greater than 200 millimeters.	12 MPa
Flexural stress psi for members with a nominal depth of 200 millimeters or less.	10 MPa
The maximum horizontal shear.	1 MPa
AXIAL tension.	8 MPa
The maximum modulus of elasticity (E) for timber.	11 000 MPa

Where:

L is the unsupported length; and

d is the least dimension of a square or rectangular column, or the width of a square of equivalent cross-sectional area for round columns.

The allowable stress for compression perpendicular to the grain, and for horizontal shear shall not be increased by any factors such as short duration loading. Additional requirements are found in other parts of Section 6-02.3(17). Criteria for the design of lumber and timber connections are found in Section 6-02.3(17)I.

Plywood for formwork shall be designed in accordance with the methods and stresses allowed in the *APA Design/Construction Guide for Concrete Forming* as published by the American Plywood Association, Tacoma, Washington. As concrete forming is a special application for plywood, wet stresses shall be used and then adjusted for forming conditions such as duration of load, and experience factors. Concrete pour pressures shall be per Section 6-02.3(17)J.

Steel:

For identified grades of steel, design stresses shall not exceed those specified in the *Manual of Steel Construction - Allowable Stress Design, Ninth Edition* by the American Institute of Steel Construction, except as follows:

Compression, flexural but not to exceed $0.6F_y$	$\frac{85\ 000\ \text{MPa}}{Ld/bt}$
The modulus of elasticity (E) shall be	200 000 MPa

When the grade of steel cannot be positively identified as with salvaged steel if rivets are present, design stresses shall not exceed the following:

Yield point f_y	210 MPa
Tension, axial, and flexural	110 MPa
Compression, axial except L/r shall not exceed 120	$98\ \text{MPa} - 0.37(KL/r)^2$
Shear on gross section of the web of rolled shapes	65 MPa
Web crippling for rolled shapes	155 MPa
Compression, flexural but not to exceed 110.3 MPa and L/b not greater than 39	$110.3 - 5.2(L/b)^2$
The modulus of elasticity (E) shall be	200 000 MPa

Where:

L is the unsupported length;

d is the least dimension of rectangular columns, or the width of a square of equivalent cross-sectional area for round columns, or the depth of beams;

b is the flange width;

t is the thickness of the compression flange;

r is the radius of gyration of the compression flange about the weak axis of the member; and

F_y is the specified minimum yield stress, MPa, for the grade of steel used.

All dimensions are expressed in millimeters.

6-02.3(17)C Falsework and Formwork at Special Locations

In addition to the minimum requirements specified in Sections 6-02.3(17)A and 6-02.3(17)B, falsework towers or posts supporting beams directly over to roadways or railroads which are open to traffic or the public shall be designed and constructed so that the falsework will be stable if subjected to impact by vehicles. The use of damaged materials, unidentifiable material, salvaged steel or steel with burned holes or questionable weldments shall not be used for falsework described in this section. For the purposes of this specification the following public or private facilities shall also be considered as "roadways": pedestrian pathways and other structures such as bridges, walls, and buildings.

The dimensions of the clear openings to be provided through the falsework for roadways, railroads, or pedestrian pathways shall be as specified in the Contract.

Falsework posts or shoring tower systems which support members that cross over a roadway or railroad shall be considered as adjacent to roadways or railroads. Other falsework posts or shoring towers shall be considered as adjacent to roadways or railroads only if the following conditions apply:

1. Located in the row of falsework posts or shoring towers nearest to the roadway or railroad; and
2. Horizontal distance from the traffic side of the falsework to the edge of pavement is less than the total height of the falsework and forms; or
3. The total height of the falsework and forms is greater than the horizontal clear distance between the base of the falsework and a point 3 meters from the centerline of track.

The Contractor shall provide any additional features for the work needed to ensure that the falsework will be stable for impact by vehicles; providing adequate safeguards, safety devices, protective equipment, and any other needed actions to protect property and the life, health, and safety of the public; and shall comply with the provisions in Section 1-07.23 and Section 6-02.3(17)M. The falsework design at special locations, shall incorporate the minimum requirements detailed in this Section, even if protected by concrete median barrier.

The vertical load used for the design of falsework posts and towers which support the portion of the falsework over openings, shall be the greater of the following:

1. 150 percent of the design load calculated in accordance with Section 6-02.3(17)B, but not including any increased or redistributed loads caused by the post-tensioning forces; or
2. 100 percent of the design load plus the increased or redistributed loads caused by the post-tensioning forces.

Each falsework post or each shoring tower leg adjacent to roadways or railroads shall consist of either steel with a minimum section modulus about each axis of 156 x 10^3 millimeters cubed or sound timbers with a minimum section modulus about each axis of 4 x 10^6 millimeters cubed.

Each falsework post or shoring tower leg adjacent to roadways or railroads shall be mechanically connected to its supporting footing at its base, or otherwise laterally restrained, to withstand a force of not less than 8900 newtons applied at the base of the post or tower leg in any direction except toward the roadway or railroad track. Posts or tower legs shall be connected to the falsework cap and stringer by mechanical connections capable of resisting a load in any horizontal direction of not less than 4400 newtons.

For falsework spans over roadways and railroads, all falsework stringers shall be mechanically connected to the falsework cap or framing. The mechanical connections shall be capable of resisting a load in any direction, including uplift on the stringer, of not less than 2200 newtons. All associated connections shall be installed before traffic is allowed to pass beneath the span.

When timber members are used to brace falsework bents which are located adjacent to roadways or railroads, all connections shall be bolted through the members using 16 millimeters diameter or larger bolts.

Concrete traffic barrier shall be used to protect all falsework adjacent to traveled roadways. The falsework shall be located so that falsework footings, mudsills, or piles are at least 0.6 meter clear of the traffic barrier and all other falsework members shall also be at least 0.6 meter clear of the traffic barrier. Traffic barrier used to protect falsework shall not be fastened, guyed, or blocked to any falsework but shall be fastened to the pavement according to details shown in the Plans. The installation of concrete traffic barrier shall be completed before falsework erection is begun. The traffic barrier at the falsework shall not be removed until approved by the Engineer. Falsework openings which are provided for the Contractor's own use (not for public use) shall also use concrete traffic barrier to protect the falsework, except the minimum clear distance between the barrier and falsework footings, mudsills, piles, or other falsework members shall be at least 75 millimeters.

Falsework bents within 6 meters of the center line of a railroad track shall be braced to resist the required horizontal load or 8900 newtons whichever is greater.

Pedestrian openings through falsework shall be paved or surfaced with full width continuous wood walks which shall be wheel chair accessible and shall be kept clear. Pedestrians shall be protected from falling objects and water falling from construction above. Overhead protection for pedestrians shall extend at least 1.2 meters beyond the edge of the bridge deck. Plans and details of the overhead protection and pathway shall be submitted with the falsework plans for review and approval. Pedestrian openings through falsework shall be illuminated by temporary lighting, constructed and maintained by the Contractor. The temporary lighting shall be constructed in accordance with local electrical code requirements. The temporary lighting shall be steady burning 60 watt, 120 volt lamps with molded waterproof lamp holders spaced at 7 meters centers maximum. All costs relating to pedestrian pathway paving, wood walks, overhead protection, maintenance, operating costs, and temporary pedestrian lighting shall be incidental to applicable adjacent items of work.

6-02.3(17)D Falsework Support Systems: Piling, Temporary Concrete Footings, Timber Mudsills, Manufactured Shoring Towers, Caps, and Posts

The Contractor shall support all falsework on either driven piling, temporary concrete footings, or timber mudsills. Temporary concrete footings shall be designed as reinforced concrete which may be either cast in place or precast. All components for a falsework support system shall be sized for the maximum design loads and allowable stresses described in the preceding sections.

The falsework drawings shall include a superstructure placing diagram showing the concrete placing sequence, direction of placements, and construction joint locations. When a sequence for placing concrete is shown in the Contract Plans or Specifications, no deviation will be permitted.

If the Plans call for piling or foundation shafts to support permanent structures, the Contractor may not use mudsills or temporary concrete footings for falsework support unless the underlying soil passes the settlement test described in this section.

Piling:

When using piling to support the falsework, the Contractor's falsework plans shall specify the minimum required bearing and depth of penetration for the piling. Also, the falsework drawings shall show the maximum horizontal distance that the top of a falsework pile may be pulled in order to position it under its cap. The falsework plans shall show the maximum allowable deviation of the top of the pile, in its final position, from a vertical line through the point of fixity of the pile. The calculations shall account for pile stresses due to combined axial and flexural stress and secondary stresses.

Timber piling (untreated) shall be banded before driving. The following shall be identified in the falsework plans: lengths, minimum tip diameter, and expected diameter at ground line. The Contractor shall comply with the requirements of Sections 9-10.1 and 9-10.1(1). The maximum allowable load for timber piles shall be 400 kiloNewtons. Steel piling shall be identified in the falsework plans. If steel pipe piling is used, the pipe diameter and wall thickness shall be identified in the falsework plans. Steel piling shall meet the requirements of Section 9-10.5. The formulas in Section 6-05.3(12) shall be used to determine the bearing capacity of the falsework piling. If the Engineer approves, the pile bearing capacity may instead be determined by test loading the piling to twice the falsework design load. The Contractor shall provide the Engineer an opportunity to witness these tests and provide a plan of the test and cross-sections showing the locations and elevations of the proposed tests to the Engineer for approval.

Temporary Concrete Footings and Timber Mudsills:

Timber mudsills or temporary concrete footings may be used in place of driven piling, provided tests show that the soil can support twice the falsework design load and that the mudsill or temporary concrete footing will not settle more than 6 millimeters when loaded with the design load. The tests shall be done at the falsework site, at the same elevation of the mudsill, and conducted under conditions representative of the actual site conditions. The acceptable tests for various soil types are:

1. Granular Soil — The Contractor shall conduct on-site tests according to the AASHTO 235 "Standard Method Test for Bearing Capacity of Soil for Static Load on Spread Footings." The Contractor shall provide the Engineer an opportunity to witness these tests and provide a plan of the test and cross-sections showing the locations and elevations of the proposed tests to the Engineer for approval.
2. Fine Grained or Organic Soil — The Contractor shall employ a Geotechnical Engineer to investigate the foundation soils and certify in writing that each mudsill or temporary footing will meet the load-settlement requirements described above. The allowable bearing capacities, elevations and locations of specific falsework mudsills shall be listed in the certification. Soils information used to determine the soil bearing capacity and settlement shall be submitted with the written certification to the Engineer for review and approval.

Timber mudsills or temporary concrete footings for falsework shall be designed to carry the loads imposed upon them without exceeding the estimated soil bearing capacity and specified maximum settlement. Where mudsills or temporary footings are used in the vicinity of permanent spread footings, the allowable mudsill bearing pressure shall be less than that of the permanent footings. This is because elevation difference; smaller bearing area; and the lack of surrounding overburden provides a lower bearing capacity than the permanent spread footings. The mudsills shall be designed for bearing capacities at the

location that they are to be used. Timber mudsills or temporary concrete footings shall be designed as unyielding foundations under full design loads. The soil pressure bearing values assumed in the design of the falsework (normally not more than 145 kilopascals) shall be shown in the falsework drawings. The minimum edge distances from the edge of the post or shoring tower leg to the edge or end of the mudsill member shall be shown in the falsework drawings. Timber mudsills and temporary concrete footings shall be designed such that member deflections do not exceed 6 millimeters and that member allowable stresses are not exceeded.

Full cross-sectional views of all falsework on timber mudsills or temporary concrete footings to be placed in side slopes or above excavations shall be shown in the falsework drawings. Footings or mudsills which are stepped or placed above an excavation shall have all related geometry and slope stability items identified in the falsework plan. Details and calculations for any shoring system to support the embankment or excavation shall be included.

Mudsills or temporary concrete footings placed in benches in slopes shall be set back from the face of the slope one-half the mudsill or temporary concrete footing width, but not less than 300 millimeters. The bench including the setback shall be level in its narrow dimension. Slopes between benches measured from the top of slope at one bench to the toe of slope at the next bench below shall be no steeper than 1½ horizontal to 1 vertical.

Falsework shall be founded on a solid footing, safe against undermining, protected from softening, and capable of supporting the loads imposed. The preparation of the soil to receive the temporary footing is important to ensure that the falsework does not experience localized settlement that could result in falsework failure. In preparing the soil for a timber mudsill or temporary concrete footing, the Contractor shall:

1. Place it on dry soil that is either undisturbed or compacted to 95 percent of maximum density, as determined by the compaction control tests in Section 2-03.3(14)D performed by the Contractor and submitted to the Engineer for review;
2. Place mudsills or footings level with full contact bearing on the soil with no voids. Place each distribution plate or corbel member between the post or tower leg and the mudsill members such that there is full contact bearing;
3. Place grout or a compacted layer of fine material under the mudsill if it is supported by rock or coarse sand and gravel;
4. Provide the Engineer with a sample of any off-site material to be used under the mudsill;
5. Allow up to five working days for the Engineer's approval before using the off-site material; and
6. Provide erosion control measures to protect the soil of the mudsill or footing from undermining and softening.

Anticipated total settlements and incremental settlements of falsework and forms due to successive concrete placements shall be shown in the falsework plans. These shall include falsework footing settlement and joint take-up. Total anticipated settlements shall not exceed 25 millimeters including joint take-up. When using mudsills, the Contractor shall prepare for the possibility of reshoring with the use of such devices as screw jacks or hydraulic jacks and adjustment of wedge packs. The placing of concrete shall be discontinued if unanticipated settlement occurs, including settlements that deviate more than plus or minus 10 millimeters from those indicated on the approved falsework drawing. Concrete placement shall not resume until corrective measures satisfactory to the Engineer are provided. If satisfactory corrective measures are not provided prior to initial set of the

concrete in the affected area, placing of concrete shall be discontinued at a location determined by the Engineer. All unacceptable concrete shall be removed as determined by the Engineer.

Where the maximum leg load exceeds 130 kiloNewtons, foundations for individual steel towers shall be designed and constructed to provide uniform settlement at each tower leg for all loading conditions.

Bents, Shoring Towers, Piling, Posts, and Caps:

Plans for falsework bents or shoring tower systems, including manufactured tower systems shall have plan, cross-section, and elevation view scale drawings showing all geometry. Show in the falsework plans the proximity of falsework to utilities or any nearby structures including underground structures. The ground elevation, cross-slopes, relation of stringers to one another, and dimensions to posts or piling shall be shown in the falsework plans. Column, pile, or tower heights shall be indicated. Member sizes, wall thickness and diameter of steel pipe columns or piles shall be shown in the falsework plans. Location of wedges, minimum bearing area and type of wedge material shall be identified in the falsework plans. Bracing size, location, material and all connections shall be described in the falsework plans.

The relationship of the falsework bents or shoring tower systems to the permanent structure's pier and footing shall be shown. Load paths shall be as direct as possible. Loads shall be applied through the shear centers of all members to avoid torsion and buckling conditions. Where loads cause twisting, biaxial bending, or axial loading with bending, the affected members shall be designed for combined stresses and stability.

Posts or columns shall be constructed plumb with tops and bottoms carefully cut to provide full end bearing. Caps shall be installed at all bents supported by posts or piling unless approved falsework plans specifically permit otherwise. Caps shall be fastened to the piling or posts. The falsework shall be capable of supporting non uniform or localized loading without adverse effect. For example, the loading of cantilevered ends of stringers or caps shall not cause a condition of instability in the adjacent unloaded members.

Timber posts and piling shall be fastened to the caps and mudsills by through-bolted connections, drift pins, or other approved connections. The minimum diameter of round timber posts shall be shown in the falsework plans. Timber caps and timber mudsills shall be checked for crushing from columns or piling under maximum load.

Steel posts and piling shall be welded or bolted to the caps, and shall be bolted or welded to the foundation. Steel members shall be checked for buckling, web yielding, and web crippling.

Wedges shall be used to permit formwork to be taken up and released uniformly. Wedges shall be oak or close-grained Douglas fir. Cedar wedges or shims shall not be used anywhere in a falsework or forming system. Wedges shall be used at the top or bottom of shores, but not at both top and bottom. After the final adjustment of the shore elevation is complete, the wedges shall be fastened securely to the sill or cap beam. Only one set of wedges (with one optional block) shall be used at one location. Screw jacks (or other approved devices) shall be used under arches to allow incremental release of the falsework.

Sand jacks may be used to support falsework and are used for falsework lowering only. Sand jacks shall be constructed of steel with snug fitting steel or concrete pistons. Sand jacks shall be filled with dry sand and the jack protected from moisture throughout its use. They shall be designed and installed in such a way to prevent the unintentional migration or loss of sand. All sand jacks shall be tested per Section 6-02.3(17)G.

When falsework is over or adjacent to roadways or railroads, all details of the falsework system which contribute to the horizontal stability and resistance to impact shall be installed at the time each element of the falsework is erected and shall remain in place until the falsework is removed. For other requirements see Section 6-02.3(17)C.

Transverse construction joints in the superstructure shall be supported by falsework at the joint location. The falsework shall be constructed in such a manner that subsequent pours will not produce additional stresses in the concrete already in place.

Manufactured Shoring Tower Systems and Devices:

Manufactured proprietary shoring tower systems shall be identified in the falsework plans by make and model and safe working load capacity per leg. The safe working load for shoring tower systems shall be based upon a minimum 2½ to 1 factor of safety.

The safe working load capacity, anticipated deflection (or settlement), make and model shall be identified in the falsework plans for manufactured devices such as: single shores, overhang brackets, support bracket and jack assemblies, friction collars and clamps, hangers, saddles, and sand jacks. The safe working load for shop manufactured devices shall be based on a minimum ultimate strength safety factor of 2 to 1. The safe working load for field fabricated devices and all single shores shall be based on a minimum ultimate strength safety factor of 3 to 1.

The safe working load of all devices shall not be exceeded. The design loads shall be as defined by Section 6-02.3(17)A. The maximum allowable free end deflection of deck overhang brackets under working loads applied shall not exceed 5 millimeters measured at the edge of the concrete slab regardless of the fact that the deflection may be compensated for by pre-cambering or of setting the elevations high. The Contractor shall comply with all manufacturer's specifications; including those relating to bolt torque, placing washers under nuts and bolt heads, cleaning and oiling of parts, and the reuse of material. Devices which are deteriorated, bent, warped, or have poorly fitted connections or welds, shall not be installed.

Shoring tower or device capacity as shown in catalogs or brochures published by the manufacturer shall be considered as the maximum load which the shoring is able to safely support under ideal conditions. These maximum values shall be reduced for adverse loading conditions; such as horizontal loads, eccentricity due to unbalanced spans or placing sequence, and uneven foundation settlement.

Depending on load-carrying capacity, steel shoring systems are classified as pipe-frame systems, intermediate strength systems, and heavy-duty systems. The two types of pipe-frame shoring base frames in general use are the ladder type and the cross-braced type. In the ladder type, frame rigidity is provided by horizontal struts between the vertical legs, whereas in the cross-braced type rigidity is provided by diagonal cross-bracing between the legs.

Copies of catalog data and/or other technical data shall be furnished with the falsework plans to verify the load-carrying capacity, deflection, and manufacturers installation requirements of any manufactured product or device proposed for use. Upon request by the Engineer, the Contractor shall furnish manufacturer certified test reports and results showing load capacity, deflection, test installation conditions, and identify associated components and hardware for shoring tower systems or other devices. In addition to manufacturer's requirements, the criteria shown in the following sections for manufactured proprietary shoring tower systems and devices shall be complied with when preparing falsework plans, calculations, and installing these shoring tower systems and devices as falsework.

Alternative criteria and/or systems may be approved if a written statement on the manufacturer's letter head, signed by the shoring or device manufacturer (not signed by a material supplier or the Contractor) is submitted to the Engineer for approval and addresses the following:

1. Identity of the specific Contract on which the alternative criteria and/or system will apply;
2. Description of the alternative criteria and/or system;
3. Technical data and test reports;
4. The conditions under which the particular alternative criteria may be followed;
5. That a design based on the alternative criteria will not overstress or over deflect any shoring component or device nor reduce the required safety factor.

In any case where the falsework drawings detail a manufactured product and the manufacturer's safe working load, load versus deflection curves, factor of safety, and installation requirements cannot be found in any catalog, the Engineer may require load testing per Section 6-02.3(17)G to verify the safe working load and deflection characteristics.

Tower leg loads shall not exceed the limiting values under any loading condition or sequence. Frame extensions and any reduced capacity shall be shown in the falsework plans. Screw jacks shall fit tight in the leg assemblies without wobble. Screw jacks shall be plumb and straight. Shoring towers shall be installed plumb, and load distribution beams shall be arranged such that vertical loads are distributed to all legs for all successive concrete placements. There shall be no eccentric loads on shoring tower heads unless the heads have been designed for such loading. Shoring towers shall remain square or rectangular in plan view and shall not be skewed. There shall be no interchanging of parts from one manufactured shoring system to another. Bent or faulty components shall not be used.

For manufactured shoring towers that allow ganging of frames, the number of ganged frames shall be limited to one frame per opposing side of a tower, and the total number of legs per ganged tower shall not exceed eight legs. Ganged frames shall be installed per the manufacturer's published standards using the manufacturer's components. Other gang arrangements shall not be used.

For manufactured steel shoring tower systems, the contractor shall have bracing designed and installed for horizontal loads and falsework overturning per Section 6-02.3(17)A. Minimum bracing criteria and allowable leg loads are described in the following paragraphs.

All shoring tower systems and bracing shall be thoroughly inspected by the Contractor for plumb vertical support members, secure connections, and straight bracing members immediately prior to, at intervals during, and immediately after every concrete placement. For manufactured shoring tower systems, the maximum allowable deviation from the vertical is 4 millimeters in 1 meter. If this tolerance is exceeded, concrete shall not be placed until adjustments have brought the shoring towers within the acceptable tolerance.

Cross-Braced Type Base Frames:

The maximum allowable load per leg for cross-braced type base frame shoring is limited by the height of the extension frame and the type of screw jack (swivel or fixed head) used at the top of the frame. The maximum load on one leg of a frame shall not exceed four times the load on the other leg under any given loading condition or sequence. The maximum load on one of the two frames making up a tower shall not exceed four times the

load on the opposite frame under any given loading condition or sequence. If swivel-head screw jacks are used, the allowable leg loads shall not exceed that shown in the following table:

Maximum Allowable Leg Load in KiloNewtons

Extension Frame Height (meters)	**0.6**	**0.9**	**1.2**	**1.5**
Screw height 300 mm or less	50	50	44	42
Screw height exceeds 300 mm	36	36	36	35

If fixed-head screw jacks are used at the top of the extension frame, the maximum allowable load per leg shall be 50 kiloNewtons for all extension frame heights up to 1.5 meters with screw jack height extensions of 300 millimeters or less. Fixed-head screw jacks exceeding 300 millimeters shall use the values in the table above. Screw jack extensions shall not exceed the manufacturer's published recommendations. Extension frames shall be braced. Side cross-braces are required for extension heights up to 0.6 meter. Both side and end cross-braces are required from over 0.6 meter to 1.5 meters extension heights.

Supplemental bracing shall be installed on shoring towers 6 meters or more in height and shall connect rows of towers to each other so rows of frames are continuously cross-braced in one plane. Supplemental bracing shall be installed as follows:

1. In the transverse direction (the direction parallel to the frame) one horizontal brace and one diagonal brace shall be attached to each tower face, for every three frames of shoring height, including an extension frame if used. The lowest horizontal brace shall be located near the top of the third tower frame, and any additional horizontal braces spaced no farther than three frames apart. The diagonal braces shall be located on opposite tower faces, and shall run in opposite directions across the plane of the tower row.
2. In the longitudinal direction (the direction perpendicular to the frames), when shoring height is four frames or more, a horizontal brace shall be installed on one face of each tower, with the lowest brace located no higher than the top of the fourth frame and any additional horizontal braces spaced no farther than four frames apart. When shoring height is six frames or more, diagonal cross-bracing shall be installed in the longitudinal direction similar to the transverse direction.
3. When roadway grade, soffit profile, or superelevation exceeds 4 percent slope for any height of shoring tower, a continuous brace parallel to the slope shall be attached to each frame extension or screw jack of the tower within 150 millimeters of the top. These braces shall be in addition to bracing previously described.

The bracing shall be fastened securely to each frame leg and shall be located within 150 millimeters of the frame member intersections. The ends of diagonal braces shall not be attached to shoring frames at locations where towers have little or no load. Diagonal brace ends shall be attached to tower frames near the top and bottom at locations where significant gravity load is maintained throughout all construction sequences, such as directly below box girder outside webs, thus precluding lift-off due to the vertical component of the brace reaction. Supplemental bracing shall be shown in the falsework drawings. The connection details, including the method of connection and exact location of the connecting devices, shall be in accordance with the manufacturer's recommendations and shall be shown in the falsework drawings.

Ladder Type Base Frames:

Ladder type base frame shoring shall be limited to the following maximum loads and conditions, regardless of any conflicting information which may be found in manufacturer's catalogs or brochures:

1. If the shoring system consists of a single tier of braced base frames, leg loads shall not exceed 44 kiloNewtons.
2. If the shoring system consists of two or three tiers of base frames, leg loads shall not exceed 33 kiloNewtons.
3. If an extension staff is used, the maximum allowable leg load shall be reduced to 27 kiloNewtons.
4. The maximum load on one leg of a frame shall not exceed four times the load on the other leg under any given loading condition or sequence. The maximum load on one of the two frames making up a tower shall not exceed four times the load on the opposite frame under any given loading condition or sequence.

Maximum allowable leg loads as shown above shall apply when fixed-head screw jacks are used, or when swivel-head jacks are used at either the top or bottom of the tower. A screw jack extension shall not exceed 300 millimeters. Swivel-head screw jacks shall not be used at both the top and bottom of ladder-type frames. For any combination of ladder-type base frames or base frames with staff extensions, the total height of the shoring shall not exceed 6 meters, including screw jack extensions.

When roadway grade, soffit profile, or superelevation exceeds 4 percent slope for heights of shoring towers 6 meters or less, a continuous brace parallel to the slope shall be attached to each staff extension or screw jack of the tower within 150 millimeters of the top. These braces shall be attached per conditions described previously for cross-braced frames.

Intermediate Strength Shoring:

Steel shoring, consisting of cross-braced tubular members capable of carrying up to 110 kiloNewtons per tower leg, is considered intermediate strength shoring. The use of a 110 kiloNewtons type falsework shoring system shall meet the following conditions and limitations:

1. If swivel-head screw jacks are used at either the top or bottom of the tower, the maximum allowable load shall be reduced to 90 kiloNewtons per tower leg.
2. The screw-jack extensions shall not exceed 360 millimeters.
3. Extension frames shall be braced. Side cross-braces are required for all extension-frame heights. In addition, end cross-braces (braces across the face of the extension frame) shall be provided for extension frame heights of 0.9 meter or more.
4. The maximum load on one leg of a frame, or on one frame of a tower, shall not exceed four times the load on the opposite leg or frame under any given loading condition or sequence.
5. Shoring towers 6 meters or more in height shall have supplemental bracing installed in accordance with the criteria for bracing "Cross-braced Type Base Frames," except that no supplemental bracing will be required in the longitudinal direction (the direction perpendicular to the frame).
6. When roadway grade, soffit profile, or superelevation exceeds 4 percent slope for any height of shoring tower, a continuous brace parallel to the slope shall be attached to each frame extension or screw jack of the tower within 150 millimeters of the top. These braces shall be in addition to bracing required in item 5.

The use of 110 kiloNewtons shoring, when designed and erected in conformance with the above criteria, is acceptable for tower heights up to five frames plus a fully-extended extension frame plus the maximum allowable screw-jack adjustment. For any proposed use exceeding this limiting height, the Contractor shall furnish a statement signed by the shoring manufacturer covering the specific installation. The statement shall provide assurance that the shoring will carry the loads to be imposed without overstressing any shoring component or reducing the required safety factor.

Heavy-Duty Shoring Systems:

Shoring capable of carrying up to 450 kiloNewtons per tower leg is considered heavy duty shoring. The following criteria applies to these systems.

If tower legs, including any extension unit, are utilized as single-post shores braced in one direction only, the shores shall be analyzed as individual steel columns.

If the total height of the shoring does not exceed the height of a single tower unit, including any extension unit, and if both the base and extension units are fully braced in both directions in accordance with the manufacturer's recommendations, individual tower legs may be considered as capable of carrying the safe working load recommended by the manufacturer without regard to the load on adjacent legs.

If the shoring consists of two or more units stacked one above the other, either with or without an extension unit, the differential leg loading within a given tower unit shall not exceed the following limitations:

Differential Leg Loading

Maximum load on any leg in the tower unit (kiloNewtons)	Maximum to Minimum load ratio
45 or less	10 to 1
45 to 220	6 to 1
220 to 330	5 to 1
330 or more	4 to 1

A complete stress analysis of steel beams used as continuous caps over two or more tower units shall be performed to determine the effect of continuity on tower leg loads. Resulting moment shear shall be added to or subtracted from the simple beam reaction to obtain the actual leg load and may produce a significant load differential.

Heavy-duty shoring shall be diagonally braced or otherwise externally supported at the top unless the towers are stable against overturning as defined in Section 6-02.3(17)A. When designing external bracing, including cable bracing, attention shall be given to the bracing connection to the falsework. Connections shall be designed to transfer horizontal and vertical forces from the falsework to the bracing system without overstressing any tower component. All external bracing, attachment locations, and connection details shall be shown in the falsework plans.

6-02.3(17)E Stringers, Beams, Joists, Roadway Slab Support, and Deck Overhangs

All stringers, beams, joists, and roadway slab support shall be designed for the design loads, deflections, and allowable stresses described in the preceding Sections 6-02.3(17)A, B, and C and for the following conditions.

At points of support, stringers, beams, joists, and trusses shall be restrained against rotation about their longitudinal axis. The effect of biaxial bending shall be investigated in all cases where falsework beams are not set plumb and the structure cross-slope exceeds 3 percent.

For box girder and T-beam bridges, the centerline of falsework beams or stringers shall be located within 0.6 meter of the bridge girder stems and preferably directly under the stems or webs. Stringers supporting formwork for concrete box girder and T-beam slab overhangs shall be stiff enough so that the differential deflection due to the roadway slab pour is no more than 5 millimeters between the outside edge of the roadway slab and the exterior web even if camber strips can compensate for the deflection.

Friction shall not be relied upon for lateral stability of beams or stringers. If the compression flange of a beam is not laterally restrained, the allowable bending stress shall be reduced to prevent flange buckling. If flange restraint is provided and since it is impossible to predict the direction in which a compression flange will buckle, positive restraint shall be provided in both directions. Flange restraint shall be designed for a minimum load of two percent of the calculated compression force in the beam flange at the point under consideration.

Camber strips shall be used to compensate for falsework take-up and deflection, vertical alignment, and the anticipated structure dead load deflection shown in the camber diagram in the Contract Plans. Camber is the adjustment to the profile of a load-supporting beam or stringer so that the completed structure will have the lines and grades shown in the Plans. The dead load camber diagram shown in the Contract Plans is the predicted structure dead load deflection due to self mass. This dead load camber shall be increased by:

1. Amount of anticipated falsework take up;
2. Anticipated deflection of the falsework beam or stringer under the actual load imposed; and
3. Any vertical curve compensation.

Camber strips shall be fastened by nailing to the top of wood members, or by clamping or banding in the case of steel members. Camber strips shall have sufficient contact bearing area to prevent crushing under total load. As a general rule, camber strips are not required unless the total camber adjustment exceeds 6 millimeters for exterior falsework stringers and 13 millimeters for interior stringers.

On concrete box girder structures, the forms supporting the roadway slab shall rest on ledgers or similar supports and shall not be supported from the bottom slab except as provided below. The form supports shall be fastened within 460 millimeters of the top of the web walls, producing a clear span between web walls. The roadway slab forms may be supported or posted from the bottom slab if the following conditions are met:

1. Permanent access, shown in the Contract Plans, is provided to the cells, and the centerline to centerline distance between web walls is greater than 3 meters;
2. Falsework stringers designed for total load, stresses and deflections per Section 6-02.3(17)A and B are located directly below each row of posts;
3. Posts have adequate lateral restraint; and
4. All forms (including the roadway deck forms), posts, and bracing are completely removed.

The falsework and forms on concrete box girder structures supporting a sloping web and deck overhang shall consist of a lateral support system which is designed to resist all rotational forces acting on the stem, including those caused by the placement of deck slab concrete, roadway deck formwork mass, finishing machine, and other live loads. Stem reinforcing steel shall not be stressed by the construction of the roadway deck slab placement. Overhang brackets shall not be used for the support of roadway slab forms from sloping web concrete box girder bridges.

Deck slab forms between girders or webs shall be constructed such that there is no differential settlement relative to the girders. The support systems for form panels supporting concrete deck slabs and overhangs on girder bridges (such as steel plate girders and prestressed girders) shall be designed as falsework. Falsework supporting deck slabs and overhangs on girder bridges shall be supported directly by the girders so that there will be no differential settlement between the girders and the deck forms during placement of deck concrete.

6-02.3(17)F Bracing

All falsework bracing systems shall be designed to resist the horizontal design load in all directions with the falsework in either the loaded or unloaded condition. All bracing, connection details, specific locations of connections, and hardware used shall be shown in the falsework plans. Falsework diagonal bracing shall be thoroughly analyzed with particular attention given to the connections. The allowable stresses in the diagonal braces may be controlled by the joint strength or the compression stability of the diagonal. Timber bracing for timber falsework bents shall have connections designed per Section 6-02.3(17)I. Any damaged cross-bracing, such as split timber members shall be replaced. Steel strapping shall avoid making sharp angles or right-angle bends. A means of preventing accidental loss of tension shall be provided for steel strapping. See Sections 6-02.3(17)A, B, and C for design loads and allowable stresses.

Bracing shall not be attached to concrete traffic barrier, guardrail posts, or guardrail.

To prevent falsework beam or stringer compression flange buckling, cross-bracing members and connections shall be designed to carry tension as well as compression. All components, connection details and specific locations shall be shown in the falsework plans. Bracing, blocking, struts, and ties required for positive lateral restraint of beam flanges shall be installed at right angles to the beam in plan view. If possible, bracing in adjacent bays shall be set in the same transverse plane. However, if because of skew or other considerations, it is necessary to offset the bracing in adjacent bays, the offset distance shall not exceed twice the depth of the beam.

All falsework and bracing shall be inspected by the Contractor for plumbness of vertical support members, secure connections, tight cables, and straight bracing members immediately prior to, during, and immediately after every concrete placement.

Bracing shall be provided to withstand all imposed loads during erection of the falsework and all phases of construction for falsework adjacent to any roadway, sidewalk, or railroad track which is open to the public. All details of the falsework system which contribute to horizontal stability and resistance to impact, including the bolts in bracing, shall be installed at the time each element of the falsework is erected and shall remain in place until the falsework is removed. The falsework plans shall show provisions for any supplemental bracing or methods to be used to conform to this requirement during each phase of erection and removal. Wind loads shall be included in the design of such bracing or methods. Loads, connections, and materials for falsework adjacent to roadways, shall also be in accordance with Section 6-02.3(17)C.

Cable or Tension Bracing Systems:

When cables, wire rope, steel rod, or other types of tension bracing members are used as external bracing to resist horizontal forces, or as temporary bracing to support bents while falsework is being erected or removed adjacent to traffic, all elements of the bracing system shall be shown in the falsework plans. Bracing shall not be attached to concrete traffic barrier, guardrail posts, or guardrail. Any damaged bracing, such as frayed and

kinked guying systems shall be replaced. Wire rope shall avoid making sharp angles or right-angle bends and a means of preventing accidental loss of tension shall be provided. The following information shall be submitted to the Engineer for approval:

1. Cable diameter, rod, or tension member size, and allowable working load.
2. Location and method of attaching the cable, rod, or tension member to the falsework. The connecting device shall be designed to transfer both horizontal and vertical forces to the cable without overstressing any falsework component.
3. The type of cable connectors or fastening devices (such as U-bolt clips, plate clamps, etc.) to be used and the efficiency factor for each type. If cables are to be spliced, the splicing method shall be shown.
4. Method of tightening cables, rods, or tension members after installation if tightening is necessary to ensure their effectiveness. Method of preventing accidental loosening.
5. Anchorage details, including the size and mass of concrete anchor blocks, the assumed coefficient of friction for surface anchorages, and the assumed lateral soil bearing capacity for buried anchorages.
6. Method of pre-stretching or preloading cable or tension members.
7. Determination of the potential stretch or elongation of the tension member under the design load and if the resulting lateral deflection will cause excessive secondary stresses in the falsework.

Copies of manufacturer's catalog or brochure showing technical data pertaining to the type of cable to be used shall be furnished with the falsework plans. Technical data shall include the cable diameter, the number of strands and the number of wires per strand, ultimate breaking strength or recommended safe working strength, and any other information as may be needed to identify the cable.

In the absence of sufficient technical data to identify the cable, or if it is old and obviously worn, the Contractor shall perform cable breaking tests to establish the safe working load for each reel of cable furnished. For static guy cable the minimum factor of safety shall be 3 to 1. The Contractor shall provide the Engineer an opportunity to witness these tests.

When cable bracing is used to prevent the overturning of heavy-duty shoring, attention shall be given to the connections by which forces are transferred from the shoring to the cables. Cable restraint shall be designed to act through the cap system to prevent the inadvertent application of forces which the shoring is not designed to withstand. Cables shall not be attached to any tower component.

Cable splices made by lapping and clipping with "Crosby" type clamps shall not be used. Other splicing methods may be used; however, at each location where the cable is spliced, cable strength shall be verified by a load test.

When cables are used as external bracing to resist overturning of a falsework system, the horizontal load to be carried by the cables shall be calculated as follows:

1. When used with heavy-duty shoring systems, cables shall be designed to resist the difference between 1.25 times the total overturning moment and the resistance to overturning provided by the individual falsework towers.
2. When used with pipe-frame shoring systems where supplemental bracing is required, cables shall be designed to resist the difference between 1.25 times the total overturning moment and the resistance to overturning provided by the shoring system as a whole.

3. When used as external bracing to prevent overturning of all other types of falsework, including temporary support during erection and removal of falsework at traffic openings, cables shall be designed to resist 1.25 times the total overturning moment.

The maximum allowable cable design load shall be determined using the following criteria:

1. If the cable is new, or is in uniformly good condition, and if it can be identified by reference to a manufacturer's catalog or other technical publication, the allowable load shall be the ultimate strength of the cable as specified by the manufacturer, multiplied by the efficiency of the cable connector, and divided by a safety factor of 3 (i.e., safe working load = breaking strength × connector efficiency/safety factor).
2. If the cable is used but still in serviceable condition, or is new or nearly new but cannot be found in a manufacturer's catalog, the Contractor shall perform load breaking tests. In this case, the cable design load shall not exceed the breaking strength, as determined by the load test, multiplied by the connector efficiency factor, and divided by a safety factor of 3.
3. If the cable is used and still in serviceable condition, or is a new or nearly new cable which cannot be identified, and if load breaking tests are not performed, the cable design load shall not exceed the safe working load shown in the wire rope capacities table multiplied by the cable connector efficiency.

Cable connectors shall be designed in accordance with criteria shown in the following tables "Efficiency of Wire Rope Connections" and "Applying Wire Rope Clips." Cable safe working loads are provided in table "Wire Rope Capacities."

Efficiency of Wire Rope Connections
(As compared to Safe Loads on Wire Rope)

Type of Connection	Connector Efficiency
Wire Rope	100%
Sockets — Zink Type	100%
Wedge Sockets	70%
Clips — Crosby Type With Thimble	80%
Knot and Clip (Contractors Knot)	50%
Plate Clamp — Three Bolt Type With Thimble	80%
Spliced Eye and Thimble:	
6 mm and smaller	100%
10 mm to 19 mm	95%
22 mm to 25 mm	88%
29 mm to 38 mm	82%
41 mm to 51 mm	75%
54 mm and larger	70%

Wire Rope Capacities
Safe Load in KiloNewtons for New Plow Steel Hoisting Rope
6 Strands of 19 Wires, Hemp Center
(Safety Factor of 6)

Diameter Millimeters	Mass Kilograms/Meter	Safe Load KiloNewtons
6	0.15	4.7
8	0.24	6.7
10	0.34	10.0
11	0.46	13.7
13	0.60	18.5
14	0.76	21.5
16	0.94	28.2
19	1.41	35.3
22	1.92	47.7
25	2.38	66.7
29	3.02	82.7
32	3.72	102.3
35	4.51	115.2
38	5.36	136.6
41	6.29	158.8
44	7.29	183.7

Applying Wire Rope Clips

The only correct method of attaching U-bolt wire rope clips to rope ends is to place the base (saddle) of the clip against the live end of the rope, while the "U" of the bolt presses against the dead end.

The clips are usually spaced about six rope diameters apart to give adequate holding power. A wire-rope thimble shall be used in the loop eye to prevent kinking when wire rope clips are used. The correct number of clips for safe application, and spacing distances, are shown below:

Number of Clips and Spacing for Safe Application

Number of Clips Improved Plow Steel Rope Diameter Millimeters	Minimum Drop Forged	Other Material	Spacing (Millimeters)
10	2	3	75
13	3	4	90
16	3	4	100
19	4	5	115
22	4	5	135
25	5	6	150
29	6	6	170
32	6	7	190
35	7	7	210
38	7	8	230

Anchor Blocks:

Concrete anchor blocks and connections used to resist forces from external bracing shall be shown in the falsework plans. Concrete anchor blocks shall be proportioned to resist both sliding and overturning. When designing anchor block stability, the mass of the anchor block shall be reduced by the vertical component of the cable or brace tension to obtain the net or effective mass to be used in the anchorage computations. The coefficient of friction assumed in the design shall not exceed the following:

	Friction Coefficient
Anchor block set on sand	0.40
Anchor block set on clay	0.50
Anchor block set on gravel	0.60
Anchor block set on pavement	0.60

Note: Multiply the friction coefficient by 0.67 if it is likely the supporting material is wet or will become wet during the construction period.

The method of connecting the cable or brace to the anchor block is part of the anchor block design. The connection shall be designed to resist both horizontal and vertical forces.

Temporary Bracing for Bridge Girders:

Bridge girders (such as steel plate girders and prestressed girders) shall be braced and tied to resist forces that would cause rotation or torsion in the girders caused by the placing of concrete for diaphragms or the deck. These conditions also apply to bridge widenings and stage constructed bridges where construction sequences can cause rotation or torsion in the girders. Falsework support brackets or braces shall not be welded to structural steel members or reinforcing steel.

On prestressed girder spans, the Contractor shall install cross-bracing between girders at each end and midspan to prevent lateral movement or rotation. This bracing shall be placed prior to the release of the girders from the erection equipment. The bracing shall not be removed until the diaphragms or the deck have been placed and cured for a minimum of 24 hours.

When deck overhang or the distance from the centerline of the exterior girder (or outside girder of a staged construction) to the near edge of the roadway slab on a prestressed girder span exceeds the distances listed in the table below, the Contractor shall provide extra bracing for the exterior girder at the midpoint between diaphragms (or at more frequent intervals). This bracing shall include: (1) a cross-tie connecting the top flange of each exterior girder with its counterpart on the other side, and (2) braces between the bottom flanges and top flanges of all girders.

Girder Series	Distance in Millimeters
W42MG	760
W50MG	1060
W58MG	1600
W74MG	1680

If a concrete finishing machine is supported at the outside edge of the slab, the Contractor shall account for its added mass in the design of bracing.

Roadway deck forming systems may require bracing or ties between girders for the girder to adequately support the form loading. When braces, struts, or ties are required, they shall be designed and detailed by the Contractor and shall be shown in the falsework/ formwork plans submitted to the Engineer for approval. These braces, struts, and ties shall be furnished and installed by the Contractor at no additional cost to the Contracting Agency.

6-02.3(17)G Testing Falsework Devices

The Contractor shall establish the load capacity and deflection (or settlement) of all friction collars and clamps, brackets, hangers, saddles, sand jacks, and similar devices utilizing a recognized independent testing laboratory approved by the Engineer. Laboratory tests shall use the same materials and design that will be used on the project. Test loads shall be applied to the device in the same manner that the device will experience loading on the project. Any bolts or threaded rods used with the device shall be identified as to diameter, length, type, grade, and torque. Any wedges, blocks, or shims used with the device on the project shall also be tested with the device. Any adjustable jack system used as a part of a device shall be tested with the device and shall have its maximum safe working extended height identified. Devices shall not be tested in contact with the permanent structure. Independent members with the same properties as the permanent structure shall be used to test device connections.

At least fourteen (14) days prior to the test, the Contractor shall submit a test procedure and scale drawing for the Engineer's approval showing how the device will be tested and how data will be collected. The Contractor shall provide the Engineer an opportunity to witness these tests.

The approved independent testing laboratory shall provide a certified test report which shall be signed and dated. The test report shall clearly identify the device tested including trademarks and model numbers; identify all parts and materials used, including grade of steel, or lumber, member section dimensions; location, size, and the maximum tested extended height of any adjustable jacks; indicate condition of materials used in the device; indicate the size, length and location of all welds; indicate how much torque was used with all bolts and threaded rods. The report shall describe how the device was tested, report the results of the test, provide a scale drawing of the device showing the location(s) of where deflections or settlements were measured, and show where load was applied. Deflections or settlements shall be measured at load increments and the results shall be clearly graphed and labeled. Prior to installation of falsework devices named in this section, the Contractor shall submit the certified test reports to the Engineer for review and approval.

The safe working load for shop manufactured devices named in this section shall be derived by dividing the ultimate strength by a safety factor of 2.0. The safe working load for field fabricated or field modified devices (including the use of timber blocks or wedges with the device) shall be determined by dividing the ultimate strength by a safety factor of 3.0. Working load shall include masses of all successive concrete placements, falsework, forms, all load transfer that takes place during post-tensioning, and any live loads; such as workers, roadway finishing machines, and concrete delivery systems. The maximum allowable free end deflection of deck overhang brackets with combined dead and live working loads applied shall be 5 millimeters even though deflection may be compensated for by pre-cambering or setting the elevations high. The Contractor shall comply with all manufacturer's specifications; including those relating to bolt torque, cleaning and oiling of parts, and the reuse of material. Devices which are deteriorated, bent, warped or have poorly fitted connections or welds, shall not be installed.

6-02.3(17)H Formwork Accessories

Formwork accessories such as form ties, form anchors, form hangers, anchoring inserts, and similar hardware shall be specifically identified in the formwork plans including the name and size of the hardware, manufacturer, safe working load, and factor of safety. The grade of steel shall also be indicated for threaded rods, coil rods, and similar hardware. Wire form ties taper ties and welding or clamping formwork accessories to Contract Plan reinforcing steel shall not be used. Driven types of anchorages for fastening forms or form supports to concrete, and Contractor fabricated "J" hooks shall not be used. Field drilling of holes in prestressed girders is not allowed.

The following table from ACI 347R-88 provides minimum safety factors for formwork accessories The hardware proposed shall meet these minimum ultimate strength requirements or the manufacturer's minimum requirements, whichever provides the greater factor of safety. The Contractor shall attach copies of the manufacturer's catalog cuts and/or test data of hardware proposed, to the formwork plans and submit the falsework and formwork plans and calculations for review and approval per Section 6-02.3(16). In situations where catalog cuts and/or test data are not available, testing shall be performed in accordance with Section 6-02.3(17)G.

Minimum Safety Factors of Formwork Accessories*

Accessory	Safety Factor	Type of Construction
Form Tie	2.0	All applications.
Form Anchor	2.0	Formwork supporting form mass and concrete pressures only.
Form Anchor	3.0	Formwork supporting masses of forms, concrete, construction live loads, and impact.
Form Hangers	2.0	All applications.
Anchoring Inserts	2.0	Placed in previous opposing concrete placement to act as an anchor for form tie.

*Safety factors are based on ultimate strength of the formwork accessory.

The bearing area of external holding devices shall be adequate to prevent excessive bearing stress on form lumber. Form ties and form hangers shall be arranged symmetrically on the supporting members to minimize twisting or rotation of the members. Form tie elongation shall not exceed the allowable deflection of the wale or member that it supports. Inserts, bolts, coil rods, and other fasteners shall be analyzed and designed for appropriately combined bending, shear, torsion, and tension stresses. The formwork shall not be attached to Contract Plan rebar or rebar cages. However, the Contractor may install additional reinforcing steel for formwork anchorage.

Frictional resistance shall not be considered as contributing to the stability of any connection or connecting device, except those designed as friction connectors such as U-bolt friction-type connectors.

Form anchors and anchoring inserts shall be designed considering concrete strength at time of loading, available embedment, location in the member, and any other factors affecting their working strength, and shall be installed in concrete per the manufacturer's

published requirements. Form anchors and anchoring inserts embedded in previous concrete placements shall not be loaded until the concrete has reached the required design strength. The required design strength of concrete for loading of an anchor shall be shown in the formwork drawing if it is assumed that the anchor will be loaded before the concrete has reached its 28 day strength.

Installation of permanent concrete inserts, such as form ties hangers, or embedded anchor assemblies, shall permit removal of all metal to at least 13 millimeters below the concrete surface. Holes shall be patched in accordance with Section 6-02.3(14). During removal of the outer unit, the bond between the concrete and the inner unit or rod shall not be broken.

6-02.3(17)I Timber Connections

Timber connections shall be designed in accordance with the methods, stresses, and loads allowed in the *Timber Construction Manual, Third Edition* by the American Institute of Timber Construction (AITC). Timber falsework and formwork connections shall be designed using wet condition stresses for all installations West of the Cascade Range crest line and by criteria provided in the following sections. Frictional resistance shall not be considered as contributing to the stability of any timber connection.

Bolted Connections:

Tabulated values in the AITC *Timber Construction Manual-Third Edition* are based on square posts. For a round post or pile, the main member thickness shall be the side of a square post having the same cross-sectional area as the round post used.

The AITC Table 6.20 for Douglas Fir-Larch bolt Group 3 and for Hem-Fir bolt Group 8 show design values for bolts to be used when the load is applied either parallel or perpendicular to the direction of the wood grain. When the load is applied at an angle to the grain, as is the case with falsework bracing, the design value for the main member shall be obtained from the Hankinson formula shown in the AITC manual.

Design values in the AITC Table 6.20 apply only to three member joints (bolt in double-shear) in which the side members are each ½ the thickness of the main member. This joint configuration is not typical of bridge falsework where side members are usually much smaller than main members. For two member joints (single shear bolt condition), the AITC Table 6.20 values shall be adjusted by a single shear load factor as follows:

1. 0.75 for installations East of the Cascade Range crest line, except as shown in item 3 below;
2. 0.50 for installations West of the Cascade Range crest line; and
3. 0.50 for load acting at an angle to the bolt axis, as is the case with longitudinal bracing when falsework bents are skewed.

Except for connections in falsework adjacent to or over railroads or roadways, threaded rods and coil rods may be used in place of bolts of the same diameter with no reduction in the tabulated values. At openings for roadways and railroads, all connections shall be bolted using 16 millimeters diameter or larger through bolts.

Bolt holes shall be a minimum 1 millimeters to a maximum 3 millimeters larger than the bolt diameter. A washer not less than a standard cut washer shall be installed between the wood and the bolt head and between the wood and the nut to distribute the bearing stress under the bolt head and nut and to avoid crushing the fibers. In lieu of standard cut washers, metal plates or straps with dimensions at least equal to that of a standard cut washer may be substituted.

When steel bars or shapes are used as diagonal bracing, the tabulated design values shown in AITC Table 6.20 for the main members loaded parallel to grain (P value) are increased 75 percent for joints made with bolts 13 millimeters or less in diameter, 25 percent for joints made with bolts 38 millimeters in diameter, and proportionally for intermediate diameters. No increase in the tabulated values is allowed for perpendicular-to-grain loading (Q value).

Clearance requirements for end, edge, and bolt spacing distance shall be as shown below. All distances are measured from the end or side of the wood member to the center of the bolt hole. For members which are subject to load reversals the larger controlling distances shall be used for design. For parallel-to-grain loading, the minimum distances for full design load:

1. In tension, minimum end distance shall be 7 times the bolt diameter;
2. In compression, minimum end distance shall be 4 times the bolt diameter; and
3. In tension or compression, the minimum edge distance shall be 1.5 times the bolt diameter.

For perpendicular-to-grain loading, the minimum distance for full design load:

1. Minimum end distance shall be 4 times the bolt diameter;
2. Edge distance toward which the load is acting shall be at least 4 times the bolt diameter; and
3. Distance on the opposite edge shall be at least 1.5 bolt diameters.

Minimum clearance (spacing) between adjacent bolts in a row shall be 4 times the bolt diameter, measured center-to-center of the bolt holes.

When more than two bolts are used in a line parallel to the axis of the side member, additional requirements shall be followed as shown in the AITC manual.

Lag Screw Connections:

Design values for lag screws subject to withdrawal loading are found in AITC Table 6.27. Values for wood having a specific gravity of 0.51 for Douglas Fir-Larch or 0.42 for Hem-Fir shall be assumed when using the table. The withdrawal values are in newtons per millimeter of penetration of the threaded part of the lag screw into the side grain of the member holding the point, with the axis of the screw perpendicular to that member. The maximum load on a given screw shall not exceed the allowable tensile strength of the screw at the root section.

AITC recommends against subjecting lag screws to end-grain withdrawal loading. However, if this condition cannot be avoided, the design value shall be 75 percent of the corresponding value for withdrawal from the side grain.

Values in the Group II wood species column shall be used for Douglas Fir-Larch and the Group III wood species column shall be used for Hem-Fir. When the load is applied at an angle to the grain, as is the case with falsework bracing, the design value shall be obtained from the Hankinson formula shown in the AITC manual.

When lag screws are subjected to a combined lateral and withdrawal loading, as would be the case with longitudinal bracing when the falsework bents are skewed, the effect of the lateral and withdrawal forces shall be determined separately. The withdrawal component of the applied load shall not exceed the allowable value in withdrawal. The lateral component of the applied load shall not exceed the allowable lateral load value.

Lag screws shall be inserted in lead holes as follows:

1. The clearance hole for the shank shall have the same diameter as the shank, and the same depth of penetration as the length of unthreaded shank;

2. The lead hole for the threaded portion shall have a diameter equal to 60 to 75 percent of the shank diameter and a length equal to at least the length of the threaded portion. The larger percentile figure in each range shall apply to screws of the greater diameters used in Group II wood species;
3. The threaded portion of the screw shall be inserted in its lead hole by turning with a wrench, not by driving with a hammer; and
4. To facilitate insertion, soap or other lubricant shall be used on the screws or in the lead hole.

Drift Pin and Drift Bolt Connections:

When drift pins or drift bolts are used, the required length and penetration shall be determined using the following criteria. The lateral load-carrying capacity of drift pins and drift bolts driven into the side grain of a wood member shall be limited to 75 percent of the design values for a common bolt of the same diameter and length in the main member. For drift pin connections, the pin penetration into the connected members shall be increased to compensate for the absence of a bolthead and nut. For drift bolts or pins driven into the end grain of a member, the lateral load-carrying capacity shall be limited to 60 percent of the allowable side grain load (perpendicular to grain value) for an equal diameter bolt with nut. To develop this allowable load the drift bolt or pin shall penetrate at least 12 diameters into the end grain. To fully develop the allowable load of the drift bolts or pins, they shall be driven into predrilled holes, 2 millimeters less in diameter than the drift pin or bolt diameter.

The criteria shown in the AITC *Timber Construction Manual-Third Edition* shall apply to drift bolt or pin connection allowable loads for the following conditions:

1. Withdrawal resistance; and
2. When there are more than two drift bolts or pins in a joint, allowable loads shall be further reduced by applying applicable modification factors shown in the AITC Table 6.3.

Nailed and Spiked Joints:

Joints using nails or spikes shall conform to the provisions of AITC. For side grain withdrawal, the values in AITC Table 6.35 for wood having a specific gravity of 0.51 for Douglas Fir-Larch and a specific gravity of 0.42 for Hem-Fir shall be used. End grain withdrawal shall not be used. For lateral loading, the values in AITC Table 6.36 for wood species Group II for Douglas Fir-Larch and wood species Group III for Hem-Fir shall be used. Diameters listed in the tables apply to fasteners before application of any protective coating.

When more than one nail or spike is used in a joint, the total design value for the joint in withdrawal or lateral resistance shall be the sum of the design values for the individual nails or spikes.

The tabulated design values for lateral loads are valid only when the nail penetrates into the main member at least 11 diameters for Douglas Fir-Larch and 13 diameters for Hem-Fir. Note that the values are maximum values for the type and size of fastener shown. The tabulated values shall not be increased even if the actual penetration is exceeded.

When main member penetration is less than 11 diameters for Douglas Fir-Larch and 13 diameters for Hem-Fir, the design value shall be determined by straight-line interpolation between zero and the tabulated load, except that penetration shall not be less than ⅓ of that specified.

Double-headed or duplex nails used in falsework and formwork construction are shorter than common wire nails or box nails of the same size designation. They have less penetration into the main member and therefore their load-carrying capacity shall be adjusted accordingly.

Nail and spike minimum spacing in timber connections shall be as follows:

1. The average center-to-center distance between adjacent nails, measured in any direction, shall not be less than the required penetration into the main member for the size of nail being used; and
2. The minimum end distance in the side member, and the minimum edge distance in both the side member and the main member, shall not be less than ½ of the required penetration.

Allowable values for withdrawal and lateral load resistance are reduced when toe nails are used in accordance with the following:

1. For withdrawal loading, the design load shall not exceed ⅔ of the value shown in the applicable design table; and
2. For lateral loading, the design load shall not exceed ⅚ of the value shown in the applicable design table.

Toe nails are recommended to be driven at an approximate angle of 30 degrees with the piece and started approximately ⅓ of the length of the nail from the end or side of the piece.

Timber Connection Adjustment for Duration of Load:

Tabulated values for timber fasteners are for normal duration of load and may be increased for short duration loading, except for connections used in falsework and formwork for post tensioned structures and staged construction sequences. Duration of load adjustment for timber connections shall not be allowed for all post tensioned structures and for staged construction sequences where delayed and/or staged loading occurs for any type of concrete structure. The adjustment for duration of load as described in this section applies only to design values for timber connectors, such as nails, bolts, and lag screws. Allowable stresses for timber and structural steel components used in the connection, as described in Section 6-02.3(17)B, are maximums and thus shall not be increased.

Tabulated values for nails, bolts, and lag screws may be adjusted by the following duration-of-load factors:

1. 1.25 for falsework design governed by the minimum design horizontal load or greater (three percent or greater of the dead load);
2. 1.33 for falsework design governed by wind load; and
3. 2.00 for falsework design governed by impact loading.

6-02.3(17)J Face Lumber, Studs, Wales, and Metal Forms

Elements of this section shall be designed for the loads, allowable stresses, deflections, and conditions which pertain from other subsections of Section 6-02.3(17).

Forms battered or inclined above the concrete will tend to lift up as concrete is placed and shall have positive anchorage or counterweights designed to resist uplift and shall be shown in the formwork plans. Where the concrete pouring sequence causes fresh concrete to be significantly higher along one side of tied forms than the opposite side, a positive form anchorage system shall be designed capable of resisting the imbalance of horizontal thrust, and prevent the dislocation and sliding of the entire form unit.

Wooden forms shall be faced with smooth sanded, exterior plywood. This plywood shall meet the requirements of the National Bureau of Standards, U.S. Product Standard PS 1, and the Design Specification of the American Plywood Association (APA). Each full sheet shall bear the APA stamp. The Contractor shall list in the form plans the grade and class of plywood. If the Engineer approves the manufacturer's certification of structural properties, the Contractor may use plywood that does not carry the APA stamp. Plywood panels stamped "shop" or "shop cutting," shall not be used.

Plyform is an APA plywood specifically designed and manufactured for concrete forming. Plyform differs from conventional exterior plywood grades in strength and the exterior face panels are sanded smooth and factory oiled. Likewise, there is a significant difference between grades designated Class 1, Class 2, and Structural I Plyform.

The grades of plywood for various form applications shall be as follows:

1. Traffic and Pedestrian Barriers (except those that will receive an architectural surface treatment) — Plywood used for these surfaces shall be APA grade High Density Overlaid (HDO) Plyform Class I. But if the Contractor coats the form to prevent it from leaving joint and grain marks on the surface, plywood that meets or exceeds APA grades B-B Plyform Class I or B-C (Group I species) may be used. Under this option, the Contractor shall provide for the Engineer's approval a 1.2 meter square, test panel of concrete formed with the same plywood and coating as proposed in the form plans. This panel shall include one form joint along its centerline. The Contractor shall apply coating material, according to the manufacturer's instructions, before applying chemical release agents.
2. Other Exposed Surfaces (all but those on traffic and pedestrian barriers) — Plywood used to form these surfaces shall meet or exceed the requirements of APA grades B-B Plyform Class I or B-C (Group I series). If one face is less than B quality, the B (or better) face shall contact the concrete.
3. Unexposed Surfaces (such as the undersides of roadway slabs between girders, the interiors of box girders, etc., and traffic and pedestrian barriers where surfaces will receive an architectural treatment) — Plywood used to form these surfaces may be APA grade CDX, provided the Contractor complies with stress and deflection requirements stated elsewhere in these Specifications.

Form joints on an exposed surface shall be in a horizontal or vertical plane. But in wingwalls and box girders, side form joints shall be placed at right angles and parallel to the roadway grade. Joints parallel to studs or joists shall be backed by a stud or joist. Joints at right angles to studs and joists shall be backed by a stud or other backing the Engineer approves. Perpendicular backing is not required if studs or joists are spaced:

1. 225 millimeters or less on center and covered with 13-millimeter plywood, or
2. 300 millimeters or less on center and covered with 19-millimeter plywood.

The face grain of plywood shall run perpendicular to studs or joists unless shown otherwise on the Contractor's formwork plans and approved by the Engineer. Proposals to deviate from the perpendicular orientation shall be accompanied by supporting calculations of the stresses and deflections.

Forming for all exposed curved surfaces shall follow the shape of the curve shown in the Contract Plans and shall not be chorded except as follows. On any retaining wall that follows a horizontal circular curve, the wall stems may be a series of short chords if:

1. The chords within the panel are the same length, unless otherwise approved by the Engineer;
2. The chords do not vary from a true curve by more than 13 millimeters at any point; and
3. All panel points are on the true curve.

Where architectural treatment is required, the angle point for chords in wall stems shall fall at vertical rustication joints.

For exposed surfaces of abutments, wingwalls, piers, retaining walls, and columns, the Contractor shall build forms of plywood at least 19 millimeters thick with studs no more than 300 millimeters on center. The Engineer may approve exceptions, but deflection of the plywood, studs, or wales shall never exceed 1/360 of the span (or 1/270 of the span for unexposed surfaces, including the bottom of the deck slab between girders).

All form plywood shall be at least 13 millimeters thick except on sharply curved surfaces. There, the Contractor may use 6-millimeter plywood if it is backed firmly with heavier material.

Round columns or rounded pier shafts shall be formed with a self-supporting metal shell form or form tube that leaves a smooth, nonspiralling surface. Wood forms are not permitted.

Metal forms shall not be used elsewhere unless the Engineer is satisfied with the surface and approves in writing. The Engineer may withdraw approval for metal forms at any time. If permitted to use a combination of wood and metal in forms, the Contractor shall coat the forms so that the texture produced by the wood matches that of the metal. Aluminum shall not be used for metal forms.

For design purposes, the Contractor shall assume that on vertical surfaces concrete exerts 23 kilopascals per meter of depth. However, when the depth is reached where the rate of placement controls the pressure, the following table applies:

Rate of Placing Meters per Hour	**Pressure, Kilopascals for Temperature of Concrete as Shown**	
	16°C	**21°C and above**
0.6	23	18
0.9	31	27
1.2	35	30
1.5	39	33
1.8	43	36
2.1	47	39
2.4	51	42
2.7	56	45
3.0	60	48
4.6	80	62

The pressures in the above table have been increased to provide an allowance for the vibration and impact.

All corners shall be beveled 19 millimeters. However, traffic barriers, footings, footing pedestals, and seals need not be beveled unless the Plans require it.

All forms shall be as mortar-tight as possible with no water standing in them as the concrete is placed.

The Contractor shall apply a parting compound on forms for exposed concrete surfaces. This compound shall be a chemical release agent that permits the forms to separate cleanly from the concrete. The compound shall not penetrate or stain the surface and shall not attract dirt or other foreign matter. After the forms are removed, the concrete surface shall be dust-free and have a uniform appearance. The Contractor shall apply the compound at the manufacturer's recommended rate to produce a surface free of dusting action and yet provide easy removal of the forms.

If an exposed concrete surface will be sealed, the release agent shall not contain silicone resin. Before applying the agent, the Contractor shall provide the Engineer a written statement from the manufacturer stating whether the resin in the base material is silicone or nonsilicone.

The Contractor shall select a parting compound from the current Qualified Products List, or submit to the Engineer a sample of the parting compound at least ten working days before its use. Approval or disapproval shall be based on laboratory test results or selection off the current Qualified Products List.

The Engineer may reject any forms that will not produce a satisfactory surface.

6-02.3(17)K Concrete Forms on Steel Spans

Concrete forms on all steel structures shall be removable and shall not remain in place. Where needed, the forms shall have openings for truss or girder members. Each opening shall be large enough to leave at least 38 millimeters between the concrete and steel on all sides of the steel member after the forms have been removed. Unit contract prices cover all costs related to these openings.

Any form support for a roadway slab that rests on a plate girder flange shall apply the load within 150 millimeters of the girder web centerline. The Contractor shall not weld any part of the form to any steel member.

If the Engineer permits bolt holes in the web to support form brackets, the holes shall be shop drilled unless otherwise approved by the Engineer. The Contractor shall fill the holes with fully torqued AASHTO M 164M bolts per Section 6-03.3(33). Each bolt head shall be placed on the exterior side of the web. There shall be no holes made in the flanges.

6-02.3(17)L Finishing Machine Support System

Before using any finishing machine, the Contractor shall obtain the Engineer's approval of detailed drawings that show the system proposed to support it. The Contractor shall not attach this (or any other) equipment support system to the sides or suspend it from any girder unless the Engineer permits. The Engineer will not permit such a method if it will unduly alter stress patterns or create too much stress in the girder.

6-02.3(17)M Restricted Overhead Clearance Sign

The Contractor shall notify the Engineer not less than 15 working days before the anticipated start of each falsework and girder erection operation whenever such falsework or girders will reduce clearances available to the public traffic. Falsework openings shall not be more restrictive to traffic than shown in the Contract Plans.

Where the height of vehicular openings through falsework is less than 4.57 meters, a W 12-2 "Low Clearance Symbol Sign" shall be erected on the shoulder in advance of the falsework and two or more W 12-301 and/or W 12-302 signs shall be attached to the falsework to provide accurate usable clearance information over the entire falsework opening. The posted low clearance shall include an allowance for anticipated falsework girder deflection (rounded-up to the next whole inch) due to design dead load, including all successive concrete pours. W 12-302 signs shall be used to designate prominent clearance restrictions and limits of usable clearance. In addition, where the clearance is less than the legal height limit (4.27 meters), a W 12-2 sign shall be erected in advance of the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around. A W 13-501 sign indicating the distance to the low clearance shall be installed below the advance sign. The Engineer will furnish the above noted signs and the Contractor shall erect and maintain them, all in accordance with Section 1-07.23(3)F.

When erecting falsework that restricts overhead clearance above a railroad track, the Contractor shall immediately (as soon as the restriction occurs) place restricted overhead clearance signs. Sign details are shown in the Standard Plans. Unit contract prices cover all costs relating to these signs.

6-02.3(17)N Removal of Falsework and Forms

The Engineer will decide, on the basis of post-placement curing conditions, the exact number of days that shall elapse before form or falsework removal. If the Engineer does not specify otherwise, the Contractor may request to remove forms based on the criteria listed in the table below. Both compressive strength and number of days criteria must be met if both are listed. The number of days shall be from the time of the last pour the forms support. In no case shall the Contractor remove forms or falsework without the Engineer's approval.

Concrete Placed In	Percent of Specified Minimum Compressive Strength	Number of Days
Columns, wall faces, mass piers and abutments (except pier caps), traffic and pedestrian barriers, and any other side form not supporting the concrete mass.[1]		3
Pier caps continuously supported.[2]	60	3
Sidewalks not supported on bridge roadway slabs.[2]	70	—
Crossbeams, caps, pier caps not continuously supported, struts and top slabs on concrete box culverts, inclined columns and inclined walls.[2,3]	80	5
Roadway slabs supported on wood or steel stringers or on steel or prestressed concrete girders.[2]	80	10
Box girders, T-beam girders, and flat-slab superstructure.[2,3]	80	14
Arches.[2,3]	—	21

[1]Where forms do not support the load of concrete.
[2]Where forms support the load of concrete.
[3]Where continuous spans are involved, the time for all spans will be determined by the last concrete placed affecting any span.

Before releasing supports from beneath beams and girders, the Contractor shall remove forms from columns to enable the Engineer to inspect the column concrete.

The Contractor may remove the side forms of footings 24 hours after concrete placement if a curing compound is applied immediately. But this compound shall not be applied to that area of the construction joint between the footing and the column or wall.

The Contractor may remove side forms, traffic barrier forms, and pedestrian barrier forms after 24 hours if these forms are made of steel or dense plywood, an approved water reducing additive is used, and the concrete reaches a compressive strength of 10 megapascals before form removal. This strength shall be proved by test cylinders made from the last concrete placed into the form. The cylinders shall be cured according to Field Operating Procedure for AASHTO T 23, Method 2.

Wet curing shall comply with the requirements of Section 6-02.3(11). The concrete surface shall not become dry during form removal or during the entire curing period.

Before placing forms for traffic and pedestrian barriers, the Contractor shall completely release all falsework under spans.

Before releasing forms under concrete subjected to temperatures colder than 10°C, the Contractor shall first prove that the concrete meets desired strength — regardless of the time that has elapsed.

The Engineer may approve leaving in place forms for footings in cofferdams or cribs. This decision will be based on whether removing them would harm the cofferdam or crib and whether the forms will show in the finished structure.

All cells of a box girder structure which have permanent access shall have all forms completely removed, including the roadway deck forms. All debris and all projections into the cells shall be removed. Unless otherwise shown in the Plans. The roadway slab interior forms in all other cells where no permanent access is available, may be left in place.

Falsework and forms supporting sloping exterior webs shall not be released until the roadway deck and deck overhang concrete has obtained its removal strength and number of days criteria listed in the table above. Stem reshoring shall not be used.

Open joints shown in the Plans shall have all forms completely removed, including Styrofoam products and form anchors, allowing the completed structure to move freely.

If the Contractor intends to support or suspend falsework and formwork from the bridge structure while the falsework and formwork is being removed, the Contractor shall submit a falsework and formwork removal plan and calculations for review and approval. The falsework and formwork removal plan shall include the following:

1. The location and size of any cast-in-place falsework lowering holes and how the holes are to be filled;
2. The location, capacity, and size of any attachments, beams, cables, and other hardware used to attach to the structure or support the falsework and formwork;
3. The type, capacity and factor of safety, mass, and spacing of points of reaction of lowering equipment; and
4. The mass at each support point of the falsework and formwork being lowered.

All other forms shall be removed whether above or below the level of the ground or water. Sections 6-02.3(7) and 6-02.3(8) govern form removal for concrete exposed to sea water or to alkaline water or soil. The forms inside of hollow piers, girders, abutments, etc. shall be removed through openings shown in the Plans or approved by the Engineer.

6-02.3(17)O Early Concrete Test Cylinder Breaks

The fabrication, curing, and testing of the early cylinders shall be the responsibility of the Contractor. Early cylinders are defined as all cylinders tested in advance of the design age of 28 days whose purpose is to determine the in-place strength of concrete in a structure prior to applying loads or stresses. The Contractor shall retain an independent testing laboratory to perform this work.

The concrete cylinders shall be molded in accordance with Field Operating Procedure for AASHTO T 23 from concrete last placed in the forms and representative of the quality of concrete placed in that pour.

The cylinders shall be cured in accordance with Field Operating Procedure for AASHTO T 23, Method 2. The Engineer may approve the use of cure boxes meeting the requirements of this test method. Special cure boxes to enhance cylinder strength will not be allowed.

The concrete cylinders shall be tested for compressive strength in accordance with Field Operating Procedure for AASHTO T 22. The number of early cylinder breaks shall be in accordance with the Contractor's need and as approved by the Engineer.

The Contractor shall furnish the Engineer with all test results. The test results will be reviewed and approved before any forms are removed. The Contractor shall not remove forms without the approval of the Engineer.

Test laboratories used for this work shall be approved by the Engineer.

All costs in connection with furnishing cylinder molds, fabrication, curing, and testing of early cylinders shall be included in the unit contract prices for the various bid items of work involved.

6-02.3(18) Placing Anchor Bolts

The Contractor shall comply with the following requirements in setting anchor bolts in piers, abutments, or pedestals:

1. If set in the wet concrete, the bolts shall be accurately placed before the concrete is placed.
2. If the bolts are set in drilled holes, hole diameter shall exceed bolt diameter by at least 25 millimeters. Grouting shall comply with Section 6-02.3(20).
3. If the bolts are set in pipe, grouting shall comply with Section 6-02.3(20).
4. If freezing weather occurs before bolts can be grouted into sleeves or holes, they shall be filled with an approved antifreeze solution (non-evaporating).

6-02.3(19) Bridge Bearings

6-02.3(19)A Elastomeric Bearing Pads

The Contractor shall use rubber cement to bond the lower contact surface of elastomeric bearing pads to the structure.

6-02.3(19)B Bridge Bearing Assemblies

For all fixed, sliding, or rolling bearings, the Contractor shall:

1. Machine all sliding and rolling surfaces true, smooth, and parallel to the movement of the bearing;
2. Polish all sliding surfaces;
3. Anchor expansion bearings securely, setting them true to line and grade;
4. Coat all sliding surfaces thoroughly with oil and graphite just before placing them into position; and
5. Avoid placing concrete in such a way that it might interfere with the free action of any sliding or rolling surface.

Grout placement under steel bearings shall comply with Section 6-02.3(20).

6-02.3(20) Grout for Anchor Bolts and Bridge Bearings

Grout shall be a prepackaged grout, mixed, placed, cured as recommended by the manufacturer, or the grout shall be produced using Type I or II Portland cement, fine aggregate Class 1 or Class 2, and water, in accordance with these Specifications.

Grout shall meet the following requirements:

Requirement	Compressive Strength
Test Method	AASHTO T 106
Values	28 MPa @ 7 days

Grout shall be a workable mix with flowability suitable for the intended application.

If the Contractor elects to use a prepackaged grout, a material sample and laboratory test data from an independent testing laboratory shall be submitted to the Engineer for approval with the request for approval of material sources.

If the Contractor elects to use a grout consisting of Type I or II Portland cement, fine aggregate Class 1, admixture, and water, the mix proportions and laboratory test data from an independent test laboratory shall be submitted to the Engineer for approval with the request for approval of material sources.

The Contractor shall receive approval from the Engineer before using the grout.

Field grout cubes shall be made in accordance with WSDOT Test Method 813 for either prepackaged grout or a contractor provided mix when requested by the Engineer, but not less than one per bridge pier or one per day.

Before placing grout, the concrete on which it is to be placed shall be thoroughly cleaned, roughened, and wetted with water to ensure proper bonding. The grout pad shall be cured as recommended by the manufacturer or kept continuously wet with water for three days.

Before placing grout into anchor bolt sleeves or holes, the cavity shall be thoroughly cleaned and wetted to ensure proper bonding.

To grout bridge bearing masonry plates, the Contractor shall:

1. Build a form approximately 100 millimeters high with sides 100 millimeters outside the base of each masonry plate;
2. Fill each form to the top with grout;
3. Work grout under all parts of each masonry plate;
4. Remove each form after the grout has hardened;
5. Remove the grout outside each masonry plate to the base of the masonry plate;
6. Bevel off the grout neatly to the top of the masonry; and
7. Place no additional load on the masonry plate until the grout has set at least 72 hours.

After all grout under the masonry plate and in the anchor bolt cavities has attained a minimum strength of 28 megapascals, the anchor bolt nuts shall be tightened to snug-tight. “Snug-tight” means either the tightness reached by (1) a few blows from an impact wrench, or (2) the full effort of a person using a spud wrench. Once the nut is snug-tight, the anchor bolt threads shall be burred just enough to prevent loosening of the nut.

6-02.3(21) Drainage of Box Girder Cells

To drain box girder cells, the Contractor shall provide and install, according to details in the Plans, short lengths of nonmetallic pipe in the bottom slab at the low point of each cell. The pipe shall have a minimum inside diameter of 100 millimeters. If the difference in plan elevation is 50 millimeters or less, the Contractor shall install pipe in each end of the box girder cell.

6-02.3(22) Drainage of Substructure

The Contractor shall use weep holes and gravel backfill that complies with Section 9-03.12(2) to drain fill material behind retaining walls, abutments, tunnels, and wingwalls. To maintain thorough drainage, weep holes shall be placed as low as possible. Gravel backfill shall be placed and compacted as required in Section 2-09.3(1)E. In addition, if the Plans require, tiling, French or rock drains, or other drainage devices shall be installed.

If underdrains are not installed behind the wall or abutment, all backfill within 0.5 meter of weep holes shall comply with Section 9-03.12(4). Unless the Plans require otherwise, all other backfill behind the wall or abutment shall be gravel backfill for walls.

6-02.3(23) Opening to Traffic

Bridges with a roadway slab made of Portland cement concrete shall remain closed to all traffic, including construction equipment, until the concrete has reached the 28-day specified compressive strength. This strength shall be determined with cylinders made of the same concrete as the roadway and cured under the same conditions. A concrete deck bridge shall never be opened to traffic earlier than ten days after the deck concrete was placed and never before the Engineer has approved.

For load restrictions on bridges under construction, refer to Section 6-01.6.

6-02.3(24) Reinforcement

Although the Plans normally include a bar list and bending diagram, these shall be used at the Contractor's risk. The Engineer advises the Contractor to check the order from the Plans.

Field grout cubes shall be made in accordance with WSDOT Test Method 813 for either prepackaged grout or a contractor provided mix when requested by the Engineer, but not less than one per bridge pier or one per day.

Before delivery of the reinforcing bars, the Contractor shall submit to the Engineer two informational copies of the supplemental bending diagrams.

Various steel reinforcing bars, including those in crossbeams, may be shown as straight in the bar list sheets of the Plans. The Contractor shall bend these bars as required to conform to the configuration of the structure and as detailed in the Plans.

6-02.3(24)A Field Bending

If the Plans call for field bending of steel reinforcing bars, the Contractor shall bend them in keeping with the structure configuration and the Plans and Specifications.

Bending steel reinforcing bars partly embedded in concrete shall be done as follows:

Field bending shall not be done:

1. On bars size No. 14 or No. 18,
2. When air temperature is lower than 7°C,
3. By means of hammer blows or pipe sleeves, or
4. While bar temperature is in the range of 200°C to 370°C.

In field-bending steel reinforcing bars, the Contractor shall:

1. Make the bend gradually;
2. Apply heat as described in Tables 2 and 3 for bending bar sizes No. 6 thru No. 11 and for bending bar sizes No. 5 and smaller when the bars have been previously bent. Previously unbent bars of sizes No. 5 and smaller may be bent without heating;
3. Use a bending tool equipped with a bending diameter as listed in Table 1;
4. Limit any bend to these maximums — 135 degrees for bars smaller than size No. 9, and 90 degrees for bars size No. 9 and No. 11;
5. Straighten by moving a hickey bar (if used) progressively around the bend.

In applying heat for field-bending steel reinforcing bars, the Contractor shall:

1. Use a method that will avoid damages to the concrete;
2. Insulate any concrete within 150 millimeters of the heated bar area;

3. Ensure, by using temperature-indicating crayons or other suitable means, that steel temperature never exceeds the maximum temperatures shown in Table 2 below;
4. Maintain the steel temperature within the required range shown in Table 2 below during the entire bending process;
5. Apply two heat tips simultaneously at opposite sides of bars larger than size No. 6 to assure a uniform temperature throughout the thickness of the bar. For size No. 6 and smaller bars, apply two heat tips, if necessary;
6. Apply the heat for a long enough time that within the bend area the entire thickness of the bar — including its center — reaches the required temperature;
7. Bend immediately after the required temperature has been reached;
8. Heat at least as much of the bar as Table 3 below requires;
9. Locate the heated section of the bar to include the entire bending length; and
10. Never cool bars artificially with water, forced air, or other means.

Table 1
Bending Diameters for Field-Bending Reinforcing Bars

	Bend Diameter/Bar Diameter Ratio	
Bar Size	**Heat Not Applied**	**Heat Applied**
No. 4, No. 5	8	8
No. 6 through No. 9	Not Permitted	8
No. 10, No. 11	Not Permitted	10

The minimum bending diameters for stirrups and ties for No. 4 and No. 5 bars when heat is not applied shall be specified in Section 9-07.

Table 2
Preheating Temperatures for Field-Bending Reinforcing Bars

	Temperature (°C)	
Bar Size	**Minimum**	**Maximum**
No. 4	650	680
No. 5, No. 6	730	760
No. 7 through No. 9	760	790
No. 10, No. 11	790	820

Table 3
Minimum Bar Length to be Heated
(d = nominal diameter of bar)

	Bend Angle		
Bar Size	**45°**	**90°**	**135°**
No. 4 through No. 8	8d	12d	15d
No. 9	8d	12d	Not Permitted
No. 10, No. 11	9d	14d	Not Permitted

6-02.3(24)B Protection of Materials

The Contractor shall protect reinforcing steel from all damage. When placed into the structure, the steel shall be free from dirt, loose rust or mill scale, paint, oil, and other foreign matter.

When transporting, storing, or constructing in close proximity to bodies of salt water, plain and epoxy-coated steel reinforcing bar shall be kept in enclosures that provide protection from the elements.

If plain or epoxy-coated steel reinforcing bar is exposed to mist, spray, or fog that may contain salt, it shall be flushed with fresh water prior to concrete placement.

When the Engineer requires protection for reinforcing steel that will remain exposed for a length of time, the Contractor shall protect the reinforcing steel:

1. By cleaning and applying a coat of paint Formula No. A-9-73 over all exposed surfaces of steel, or
2. By cleaning and painting paint Formula No. A-9-73 on the first 150 millimeters of the steel bars protruding from the concrete and covering the bars with polyethylene sleeves.

The paint shall have a minimum dry film thickness of 25.4 micrometer.

6-02.3(24)C Placing and Fastening

The Contractor shall position reinforcing steel as the Plans require and shall ensure that the steel does not move as the concrete is placed.

When spacing between bars is 0.3 meter or more, they shall be tied at all intersections. When spacing is less than 0.3 meter, every other intersection shall be tied. If the Plans require bundled bars, they shall be tied together with wires at least every 1.8 meters. Wire used for tying epoxy-coated reinforcing steel shall be plastic coated. **Tack welding is not permitted on reinforcing steel**.

Abrupt bends in the steel are permitted only when one steel member bends around another. Vertical stirrups shall pass around main reinforcement or be firmly attached to it.

For slip-formed concrete, the reinforcing steel bars shall be tied at all intersections and crossbraced to keep the cage from moving during concrete placement. Crossbracing shall be with additional reinforcing steel. Crossbracing shall be placed both longitudinally and transversely.

After reinforcing steel bars are placed in a traffic or pedestrian barrier and prior to slip-form concrete placement, the Contractor shall check clearances and reinforcing steel bar placement. This check shall be accomplished by using a template or by operating the slip-form machine over the entire length of the traffic or pedestrian barrier. All clearance and reinforcing steel bar placement deficiencies shall be corrected by the Contractor before slip-form concrete placement.

Mortar blocks (or other approved devices) shall be used to maintain the concrete coverage required by the Plans. The Mortar blocks shall:

1. Have a bearing surface measuring not greater than 50 millimeters in either dimension, and
2. Have a compressive strength equal to that of the concrete in which they are embedded.

In slabs, each mortar cube shall have either: (1) a grooved top that will hold the reinforcing bar in place, or (2) an embedded wire that protrudes and is tied to the reinforcing steel. If this wire is used around epoxy-coated bars, it shall be coated with plastic.

Mortar blocks may be accepted on a Manufacturers Certificate of Compliance, which shall include test results on sets of two 50 mm square specimens per AASHTO T 106. Each pair of specimens shall represent 2,500 or fewer mortar blocks and shall be made of the same mortar as the blocks and cured under the same conditions.

In lieu of mortar blocks, the Contractor may use metal or plastic chair supports to hold uncoated bars. Any surface of a metal chair support that will not be covered by at least 13 millimeters of concrete shall be one of the following:

1. Hot-dip galvanized after fabrication in keeping with AASHTO M 232 Class D,
2. Coated with plastic firmly bonded to the metal. This plastic shall be at least 2 millimeters thick where it touches the form and shall not react chemically with the concrete when tested in the Olympia Service Center Materials Laboratory. The plastic shall not shatter or crack at or above -15°C and shall not deform enough to expose the metal at or below 93°C, or
3. Stainless steel that meet the requirements of ASTM A 493, Type 302. Stainless steel chair supports are not required to be galvanized or plastic coated.

In lieu of mortar blocks, epoxy-coated reinforcing bars may be supported by one of the following:

1. Metal chair supports coated entirely with a dielectric material such as epoxy or plastic,
2. Other epoxy-coated reinforcing bars, or
3. Plastic chair supports.

Plastic chair supports shall be lightweight, non-porous, and chemically inert in concrete. Plastic chair supports shall have rounded seatings, shall not deform under load during normal temperatures, and shall not shatter or crack under impact loading in cold weather. Plastic chair supports shall be placed at spacings greater than 300 millimeters along the bar and shall have at least 25 percent of their gross place area perforated to compensate for the difference in the coefficient of thermal expansion between plastic and concrete. The shape and configuration of plastic supports shall permit complete concrete consolidation in and around the support.

In roadway and sidewalk slabs, the Contractor shall place reinforcing steel mats carefully to provide the required concrete cover. A "mat" is two layers of steel. Top and bottom mats shall be supported enough to hold both in their proper positions. If No. 4 bars make up the lower layer of steel in a mat, it shall be blocked at not more than 0.9-meter intervals (or 1.2-meter intervals for bars No. 5 and larger). Wire ties to girder stirrups shall not be considered as blocking. To provide a rigid mat, the Contractor shall add other supports and tie wires to the top mat as needed.

If a bar will interfere with a bridge drain, it shall be bent in the field to bypass the drain.

Clearances shall be at least:

100 millimeters between:	Main bars and the top of any concrete masonry exposed to the action of salt or alkaline water.
65 millimeters between:	Adjacent bars in a layer. Slab bars and the top of the roadway slab. Main bars and the surface of concrete deposited against earth (without intervening forms).
50 millimeters between:	Adjacent layers. Main bars and the surface of concrete (except in walls and slabs). Reinforcing bars and the faces of forms for exposed aggregate finish.
38 millimeters between:	Main bars and the surface of concrete in retaining walls. Slab bars and the top of the slab (except roadway slabs). Stirrups and ties and the surface of the concrete.
25 millimeters between:	Slab bars and the bottom of the slab. Curb or sidewalk bars and the surface of the concrete.

Reinforcing steel bars shall not vary more than the following tolerances from their position shown in the Plans:

Members 250 millimeters or less in thickness	±6 mm
Members more than 250 millimeters in thickness	±10 mm
Except:	
The distance between the nearest reinforcing steel bar surface and the top surface of the roadway deck slab	+6 mm
Longitudinal spacing of bends and ends of bars	±25 mm
Length of bar laps	-38 mm
Embedded length	
No 3 through No. 11	-25 mm
No. 14 through No. 18	-50 mm
When reinforcing steel bars are to be placed at equal spacing within a plane:	
Stirrups and ties	±25 mm
All other reinforcement	±1 bar dia.

Before placing any concrete, the Contractor shall:

1. Clean all mortar from reinforcement, and
2. Obtain the Engineer's permission to place concrete after the Engineer has inspected the placement of the reinforcing steel. (Any concrete placed without the Engineer's permission shall be rejected and removed.)

6-02.3(24)D Splicing

The Contractor shall supply steel reinforcing bars in the full lengths the Plans require. Unless the Engineer approves in writing, the Contractor shall not change the number, type, or location of splices.

The Engineer may permit the Contractor to use thermal or mechanical splices in place of the method shown in the Plans if they are of an approved design. Use of a new design may be granted if:

1. The Contractor provides technical data and proof from the manufacturer that the design will perform satisfactorily, and
2. Sample splices and materials from the manufacturer pass the Engineer's tests.

After a design has been approved, any changes in detail or material shall require new approval.

The Contractor shall:

1. Not lap-splice reinforcing bars Nos. 14 or 18.
2. Not permit any welded or mechanical splice to deviate in alignment more than 6 millimeters per 1.1 meter of bar.
3. Distribute splices evenly, grouping them together only at points of low tensile stress.
4. Ensure at least 50 millimeters clearance between any splice and the nearest bar or the surface of the concrete (or 38 millimeters for the length of the sleeve on mechanical splices).
5. Rigidly clamp or wire all splices in a way the Engineer approves.
6. Place lap-spliced bars in contact for the length of the splice and tie them together near each end.
7. Securely fasten the ends and edges of welded-wire-fabric reinforcement, overlapping them enough to maintain even strength.

6-02.3(24)E Welding Reinforcing Steel

Welding of steel reinforcing bars shall conform to the requirements of the Special Provisions, Plans, and these Specifications.

When welding is required, steel reinforcing bars shall be supplied that are suitable for welding. Steel which is to be welded shall have a maximum carbon equivalent of 0.65 percent. The carbon equivalent shall be determined by the following formula:

$$CE = \% C + \% Mn/6 + \% Cu/40 + \% Ni/20 + \% Cr/10 - \% Mo/50 - \% V/10$$

In addition, carbon shall not exceed 0.45 percent nor manganese 1.30 percent.

Before any welding begins, the Contractor shall obtain the Engineer's approval of a written welding procedure for each type of welded splice to be used, including the procedure specifications and joint details. The procedure specifications shall specify: material specification; manual or machine; position of weld; filler metal specification and classification; shielding gas; single or multiple pass; single or multiple arc; either shielded metal arc, flux cored arc, or gas metal arc welding process; preheat and interpass temperature; welding current; polarity; and root treatment. The welding procedure shall specify welding sequence, pass number, electrode size, welding current amperes and voltage for each joint detail. All the aforementioned information shall be contained on a form that specifies the procedure number, revision number, and the Contractor. The form shall be signed and dated.

Electrodes for manual shielded metal arc welding (SMAW) of Grade 400 steel reinforcing bars shall conform to the requirements of AWS A5.5 of the low hydrogen E90 series.

Solid and composite electrodes for gas metal arc welding (GMAW) and flux-cored arc welding (FCAW) of Grade 400 steel reinforcing bar shall conform to the requirements of AWS A5.28, ER90S and AWS A5.29, E90T respectively. The Contractor shall demonstrate that each combination of electrode and shielding proposed for use will produce the following mechanical properties:

FCAW Grade E90T

Tensile Strength	620 MPa
Yield Strength	540 MPa
Elongation in 50 millimeters	17%

Compliance may be verified from manufacturer's certified test reports, or from actual testing of weld specimens.

All welding shall be protected from air currents, drafts, and precipitation to prevent loss of heat or loss of arc shielding. Short circuiting transfer with gas metal arc welding will not be allowed. Slugging of welds will not be allowed. No field welding of reinforcing bars will be permitted when the ambient temperature is below 0°C.

The minimum preheat and interpass temperature for welding Grade 400 reinforcing bars shall be 200°C. Preheating shall be applied to the reinforcing bars and other splice members within 150 millimeters of the weld, unless limited by the available lengths of the bars or splice member.

Generally, postheating of welded splices is only required for direct butt welded splices of Grade 400 bars size No. 9 or larger and shall be done immediately after welding before the splice has cooled to 370°C. Postheating shall not be less than 430°C nor more than 540°C and held at this temperature for not less than 10 minutes before allowing the splice to cool naturally to ambient temperature.

Weld joint and welder qualifications shall be made by the following procedures. The joint qualification and welder qualification shall be according to the following tests.

Under supervision of the State Materials and Fabrication Inspector, the welder shall weld three test joints of the largest size reinforcing bar to be weld spliced. Two of the test welds shall be test loaded to no less than 125 percent of the minimum specified yield strength of the bar. The remaining test weld shall be mechanically cut perpendicular to the direction of welding and macroetched. Indirect butt splices shall be cut mechanically at two locations to provide a transverse cross-section of each of the bars spliced in the test assembly. The sections shall show the full cross-section of the weldment, the root of the weld, and any reinforcement. The etched cross-section shall have complete penetration and complete fusion with the base metal and between successive passes in the weld. Groove welds of direct butt splices and flare-groove welds shall not have reinforcement exceeding 3 millimeters in height measured from the main body of the bar and shall have a gradual transition to the base metal surface. No cracks will be allowed in either the weld metal or heat-affected zone. All craters shall be filled to the full cross-section of the weld. Weld metal shall be free from overlap. Undercutting deeper than 0.8 millimeter will not be allowed except at points where welds intersect the raised pattern of deformations where undercutting less than 1.6 millimeters deep will be acceptable. The sum of diameters of piping porosity in groove welds shall not exceed 3 millimeters in any 25 millimeters of weld or exceed 14 millimeters in any 150-millimeter length of weld. Corrections to welds with shielded metal arc, gas metal arc, or flux-cored arc welding processes shall be made in accordance with Engineer's approval.

A welder qualified in the vertical position shall then be qualified for the horizontal and flat positions. A welder qualified for the horizontal position shall then be qualified for the flat position but not the vertical position. A welder qualified in the flat position shall be qualified for the flat position only.

Welders qualified for direct butt splice groove welds are qualified for indirect butt splice groove welds and fillet welds. A welder qualified for indirect butt splice grooved welds is not qualified for direct butt splice welds. The welder qualifications shall remain in effect indefinitely unless, (1) the welder is not engaged in a given process of welding for which he/she is qualified for a period exceeding six months, or (2) there is some specific reason to question a welder's ability.

Weld joint geometry shall be as shown in the Plans and these Specifications. Welding machines shall be D.C. current, reverse polarity, and in good working condition.

The Contractor is responsible for using a welding sequence that will limit the alignment distortion of the bars due to the effects of welding. The maximum out-of-line permitted will be 6 millimeters from a 1.1-meter straightedge centered on the weld and in line with the bar.

The following procedure for welding steel reinforcing bars is recommended:

Sheared bar ends shall be burned or sawed off a minimum of 13 millimeters to completely remove the ruptured portion of the steel shear area prior to welding butt splices. Surfaces to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other defects. Surfaces to be welded and surfaces adjacent to a weld shall also be free from loose or thick scale, slag, rust, moisture, grease, paint, epoxy covering, or other foreign materials. All tack welds shall be within the area of the final weld. No other tack weld will be permitted. Double bevel groove welds require chipping, grinding, or gouging to sound metal at the root of the weld before welding the other side. Progression of vertical welding shall be upward. The ground wire from the welding machine shall be clamped to the bar being welded.

Should the Contractor elect to use a procedure which differs in any way from the procedure recommended, the Contractor shall submit the changes, in writing, to the Engineer for approval. Approved weld procedures shall be strictly followed.

6-02.3(24)F Mechanical Splices

The Contractor shall form mechanical splices with an Engineer-approved system using sleeve filler metal, threaded coupling, or another method that complies with this section.

If necessary to maintain required clearances after the splices are in place, the Contractor shall adjust, relocate, or add stirrups, ties, and bars.

Before splicing, the Contractor shall provide the Engineer with the following information for each shipment of splice material:

1. The type or series identification (and heat treatment lot number for threaded-sleeve splices),
2. The grade and size of bars to be spliced,
3. A manufacturer's catalog with complete data on material and procedures,
4. A written statement from the manufacturer that the material is identical to that used earlier by the Engineer in testing and approving the system design, and
5. A written statement from the Contractor that the system and materials will be used according to the manufacturer's instructions and all requirements of this section.

All splices shall meet these criteria:

1. Tension splices shall develop at least 130 percent of the yield tensile strength specified for the unspliced bar. The ultimate tensile strength of the sleeve shall exceed that of the other parts of the completed splice.
2. AASHTO M 31M bars within a splice sleeve shall not slip more than 0.8 millimeter for Grade 300 bars, nor more than 1.1 millimeters for Grade 400 bars. This slippage shall be measured between gage points clear of the splice sleeve. Measurements shall be taken at an initial load of 21 megapascals and again after loading to 90 percent of the minimum specified yield strength for the unspliced bar and then relaxed to 21 megapascals.
3. Maximum allowable bar size:
   a. Mechanical butt splice No. 14
   b. Mechanical lap splice No. 6

The Engineer will visually inspect the splices and accept all that appear to conform with the test samples. For sleeve-filler splices, the Engineer will allow voids within the limits on file in the design approval. If the Engineer considers any splice defective, it shall be removed and replaced at the Contractor's expense.

In preparing sleeve-filler metal splices, the Contractor shall:

1. Clean the bar surfaces by: (a) oxyacetylene torch followed by power wire brushing, or (b) abrasive blasting;
2. Remove all slag, mill scale, rust, and other foreign matter from all surfaces within and 50 millimeters beyond the sleeve;
3. Grind down any projection on the bar that would prevent placing the sleeve;
4. Prepare the ends of the bars as the splice manufacturer recommends and as the approved procedure requires; and
5. Preheat, just before adding the filler, the entire sleeve and bar ends to 150°C, plus or minus 10°C. (If a gas torch is used, the flame shall not be directed into the sleeve.)

When a metallic, sleeve-filler splice is used (or any other system requiring special equipment), both the system and the operator shall qualify in the following way under the supervision of the State Materials and Fabrication Inspector. The operator shall prepare six test splices (three vertical, three horizontal) using bars having the same AASHTO Designation and size (maximum) as those to be used in the work. Each test sample shall be 1070 millimeters long, made up of two 530-millimeter bars joined end-to-end by the splice. The bar alignment shall not deviate more than 3 millimeters from a straight line over the whole length of the sample. All six samples must meet the tensile strength and slip criteria specified in this section.

The Contractor shall provide labor, materials, and equipment for making these test samples at no expense to the Contracting Agency. The Contracting Agency will test the samples at no cost to the Contractor.

6-02.3(24)G Job Control Tests

As the work progresses, the Engineer may require the Contractor to provide a sample splice (thermal or mechanical) to be used in a job control test. The operator shall create this sample on the job site with the Engineer present using bars of the same size as those being spliced in the work. The sample shall comply with all requirements of these Specifications, and is in addition to all other sample splices required for qualification. The Engineer will require no more than two samples on any project with fewer than 200 splices and no more than one sample per 100 splices on any project with more than 200 splices.

6-02.3(24)H Epoxy-Coated Steel Reinforcing Bar

This work is furnishing, fabricating, coating, and placing epoxy-coated steel reinforcing bars as the Plans, these Specifications, and the Special Provisions require. Coating material shall be applied electrostatically, by spraying, or by the fluidized-bed method.

All epoxy-coated bars shall comply with the requirements of Section 9-07. Fabrication may occur before or after coating.

The Contractor shall protect epoxy-coated bars from damage using padded or nonmetallic slings and straps free from dirt or grit. To prevent abrasion from bending or sagging, the Contractor shall lift bundled bars with a strong-back, multiple supports, or a platform bridge. Bundled bars shall not be dropped or dragged. During shop or field storage, bars shall rest on wooden or padded cribbing. The Contractor may substitute other methods for protecting the bars if the Engineer approves. If the Engineer believes the coated bars have been badly damaged, they will be rejected.

Metal chairs and supports shall be coated with epoxy (or another inert coating if the Engineer approves). The Contractor may use other support devices with the Engineer's approval. Plastic coated tie wires (approved by the Engineer) shall be used to protect the coated bars from being damaged during placement.

The bars shall be placed as the Plans require and held firmly in place during placing and setting of the concrete. All epoxy-coated bars in the top mat of the roadway slab shall be tied at all intersections. Other epoxy-coated bars shall also be tied at all intersections, but shall be tied at alternate intersections when spacing is less than 0.3 meter in each direction.

In the interval between installing coated bars and concreting the deck, the Contractor shall protect the coating from damage that might result from other construction work.

The Engineer will inspect the coated bars after they are placed and before the deck concrete is placed. The Contractor shall patch any areas that show significant damage (as defined below).

Significant damage means any opening in the coating that exposes the steel in an area that exceeds:

1. 32 square millimeters (approximately 6 millimeters square or 6 millimeters in diameter or the equivalent).
2. 8 square millimeters (approximately 3 millimeters square or 3 millimeters in diameter) when the opening is within 6 millimeters of another opening of equal or larger size.
3. 150 millimeters long, any width.
4. 320 square millimeters aggregate area in any 0.3-meter length of bar.

The Contractor shall patch significantly damaged areas with Engineer-approved patching material obtained from the epoxy resin manufacturer. This material shall be compatible with the coating and inert in concrete. Areas to be patched shall be clean and free of surface contaminants. Patching shall be done before oxidation occurs and according to the resin manufacturer's instructions.

6-02.3(25) Prestressed Concrete Girders

The Contractor shall perform quality control inspection. The manufacturing plant of prestressed concrete girders shall be certified by the Precast/Prestressed Concrete Institute's Plant Certification Program for the type of prestress member to be produced and shall be approved by WSDOT as a Certified Prestress Concrete Fabricator prior to the start of production. WSDOT certification will be granted at, and renewed during, the annual prestressed plant review and approval process.

Prior to the start of production of girders, the Contractor shall advise the Engineer of the production schedule. The Contractor shall give the Inspector safe and free access to the work. If the Inspector observes any nonspecification work or unacceptable quality control practices, the Inspector will advise the plant manager. If the corrective action is not acceptable to the Engineer, the girder(s) will be rejected.

The Contracting Agency intends to perform Quality Assurance Inspection. By its inspection, the Contracting Agency intends only to facilitate the work and verify the quality of that work. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

The various types of girders are:

Prestressed Concrete Girder — Refers to prestressed concrete girders including Series W42MG, W50MG, W58MG, W74MG, W83MG, and W95MG girders, bulb tee girders, and deck bulb tee girders.

Bulb Tee Girder — Refers to a bulb tee girder or a deck bulb tee girder.

Deck Bulb Tee Girder — Refers to a bulb tee girder with a top flange designed to support traffic loads (i.e., without a cast-in-place deck). This type of bulb tee girder is mechanically connected to adjacent girders at the job site. Precast prestressed slabs and precast prestressed ribbed sections shall meet all the requirements of these specifications for deck bulb tee girders.

6-02.3(25)A Shop Plans

The Plans show design conditions and details for prestressed girders. Deviations will not be permitted, except as specifically allowed by these Specifications and by manufacturing processes approved by the annual plant approval process.

Shop plans shall show the size and location of all cast-in holes for installation of deck formwork hangers and/or temporary bracing. Holes for formwork hangers shall match approved deck formwork plans designed in accordance with Section 6-02.3(16). There shall be no field-drilled holes in prestressed girders.

The Contractor shall have the option to furnish Series W74MG prestressed concrete girders with minor dimensional differences from those shown in the Plans. The 70-millimeter top flange taper may be reduced to 40 millimeters and the bottom flange may be increased to 660 millimeters. Other dimensions of the girder shall be adjusted as necessary to accommodate the above mentioned changes. Reinforcing steel shall be adjusted as necessary. The overall height and top flange width shall remain unchanged.

If the Contractor elects to provide a Series W74MG girder with an increased web thickness, shop plans along with supporting design calculations shall be submitted to the Engineer for approval prior to girder fabrication. The girder shall be designed for at least the same load carrying capacity as the girder shown in the Plans. The load carrying capacity of the mild steel reinforcement shall be the same as that shown in the Plans.

The Contractor may alter bulb tee girder dimensions as specified from that shown in the Plans if:

1. The girder has the same or higher load carrying capacity (using current AASHTO Design Specification);
2. The Engineer approves, before the girder is made, complete design calculations for the girder;
3. The Contractor adjusts substructures to yield the same top of roadway elevation shown in the Plans;
4. The depth of the girder is not increased by more than 50 millimeters and is not decreased;
5. The web thickness is not increased by more than 25 millimeters and is not decreased;
6. The top flange minimum thickness of the girder is not increased by more than 50 millimeters, providing the top flange taper section is decreased a corresponding amount;
7. The top flange taper depth is not increased by more than 25 millimeters; and
8. The bottom flange width is not increased by more than 50 millimeters.

The Contractor shall provide four copies of the shop plans to the Engineer for approval. Only steel side forms will be approved, except plywood forms are acceptable on the end bulkheads. Approval of shop plans means only that the Engineer accepts the methods and materials. Approval does not imply correct dimensions.

6-02.3(25)B Casting

Before casting girders, the Contractor shall have possession of an approved set of shop drawings.

All concrete mixes to be used shall be pre-approved in the WSDOT plant certification process and must meet the requirements of Section 9-19.1. The temperature of the concrete when placed shall be between 10°C and 32°C.

Slump shall not exceed 100 millimeters for normal concrete nor 180 millimeters with the use of a high range water reducing admixture, nor 215 millimeters when both a high range water reducing admixture is used and the water/cement ratio is less than or equal to 0.35. The high range water reducer shall meet the requirements of Section 9-23.6 and 9-23.7.

Air-entrainment is not required in the concrete placed into prestressed precast concrete girders unless otherwise noted. The Contractor shall use air-entrained concrete in the entire roadway deck flange of deck bulb-tee girders. Maximum and minimum air content shall be as specified in Section 6-02.3(2)A.

No welds will be permitted on steel within prestressed girders. Once the prestressing steel has been installed, no welds or grounds for welders shall be made on the forms or the steel in the girder, except as specified.

The Contractor may form circular block-outs in the girder top flanges to receive falsework hanger rods. These block-outs shall:

1. Not exceed 25 millimeters in diameter;
2. Be spaced no more than 1830 millimeters apart longitudinally on the girder;
3. Be located 75 millimeters or more from the outside edge of the top flange on Series W42MG, W50MG, and W58MG girders and 150 millimeters or more for Series W74MG girders; and
4. Be located within 380 millimeters of the web centerline for bulb tee girder.

The Contractor may form circular block-outs in the girder webs to support brackets for roadway slab falsework. These block-outs shall:

1. Not exceed 25 millimeters in diameter,
2. Be spaced no more than 1830 millimeters apart longitudinally on the girder, and
3. Be positioned so as to clear the girder reinforcing and prestressing steel.

6-02.3(25)C Prestressing

Each stressing system shall have a pressure gauge or load cell that will measure jacking force. Any gauge shall display pressure accurately and readably with a dial at least 150 millimeters in diameter or with a digital display. Each jack and its gauge shall be calibrated as a unit and shall be accompanied by a certified calibration chart. The Contractor shall provide one copy of this chart to the Engineer. The cylinder extension during calibration shall be in approximately the position it will occupy at final jacking force.

Jacks and gauges shall be recalibrated and recertified:

1. Annually,
2. After any repair or adjustment, and
3. Anytime there are indications that the jack calibration is in error.

The Engineer may use pressure cells to check jacks, gauges, and calibration charts before and during tensioning.

All load cells shall be calibrated and shall have an indicator that shows prestressing force in the strand. The range of this cell shall be broad enough that the lowest 10 percent of the manufacturer's rated capacity will not be used to measure jacking force.

From manufacture to encasement in concrete, all reinforcement used in girders shall be protected against dirt, oil, grease, damage, rust, and all corrosives. If strands in the stressing bed are exposed before they are encased in concrete, the Contractor shall protect them from contamination or corrosion. The protection method requires the Engineer's approval. If steel has been damaged or if it shows rust or corrosion, it will be rejected.

6-02.3(25)D Curing

During curing, the Contractor shall keep the girder in a saturated curing atmosphere until the girder concrete has reached the required release strength. If the Engineer approves, the Contractor may shorten curing time by heating the outside of impervious forms. Heat may be radiant, convection, conducted steam, or hot air. With steam, the arrangement shall envelop the entire surface with saturated steam. The Engineer will not permit hot air curing until after approving the Contractor's proposed method to envelop and maintain the girder in a saturated atmosphere. Saturated atmosphere means a relative humidity of at least 90 percent. The Contractor shall never allow dry heat to touch the girder surface at any point.

Under heat curing methods, the Contractor shall:

1. Keep all unformed girder surfaces in a saturated atmosphere throughout the curing time;
2. Embed a thermocouple (linked with a thermometer accurate to plus or minus 3°C) 150 to 200 millimeters from the top or bottom of the girder on its centerline and near its midpoint;
3. Monitor with a recording sensor (accurate to plus or minus 3°C) arranged and calibrated to continuously record, date, and identify concrete temperature throughout the heating cycle;
4. Make this temperature record available for the Engineer to inspect;
5. Heat concrete to no more than 38°C during the first two hours after pouring the concrete, and then increase no more than 4°C per hour to a maximum of 79°C;
6. Cool concrete, after curing is complete, no more than 4°C per hour, to 38°C; and
7. Keep the temperature of the concrete above 16°C until the girder reaches release strength.

The Contractor may strip side forms once the concrete has reached a minimum compressive strength of 20 megapascals. All damage from stripping is the Contractor's responsibility.

6-02.3(25)E Contractors Control Strength

Concrete strength shall be measured on test cylinders cast from the same concrete as that in the girder. These cylinders shall be cured under time-temperature relationships and conditions that simulate those of the girder. If the forms are heated by steam or hot air, test cylinders will remain in the coolest zone throughout curing. If forms are heated another way, the Contractor shall provide a record of the curing time-temperature relationship for the cylinders for each girder to the Engineer. When two or more girders are cast in a continuous line and in a continuous pour, a single set of test cylinders may represent all girders provided the Contractor demonstrates uniformity of casting and curing to the satisfaction of the Engineer.

The Contractor shall mold, cure, and test enough of these cylinders to satisfy specification requirements for measuring concrete strength. The Contractor may use 100-millimeter by 200-millimeter or 150-millimeter by 300-millimeter cylinders.

Test cylinders may be cured in a moist room or water tank in accordance with AASHTO T-23 after the girder concrete has obtained the required release strength. If, however, the Contractor intends to ship the girder prior to the standard 28-day strength test, the design strength for shipping shall be determined from cylinders placed with the girder and cured under the same conditions as the girder. These cylinders may be placed in a noninsulated, moisture-proof envelope.

To measure concrete strength in the girder, the Contractor shall randomly select two test cylinders and average their compressive strengths. The compressive strength in either cylinder shall not fall more than 5 percent below the specified strength. If these two cylinders do not pass the test, two other cylinders shall be selected and tested.

If too few cylinders were molded to carry out all required tests on the girder, the Contractor shall remove and test cores from the girder under the surveillance of the Engineer. If the Contractor casts cylinders to represent more than one girder, all girders in that line shall be cored and tested. A test shall consist of three cores measuring 100 millimeters in diameter by the thickness of the web and shall be removed from just below the top flange; one at the midpoint of the girder's length and the other two approximately 1 meter to the left and approximately 1 meter to the right. The cores shall be taken in

accordance with AASHTO T 24 and shall be tested in accordance with AASHTO T 22. The Engineer may accept the girder if the average compressive strength of three cores is at least 85 percent of the specified compressive strength with no one core less than 75 percent of the specified compressive strength.

If the girder is cored to determine the release strength, the required patching and curing of the patch shall be done prior to shipment. If there are more than three holes or if they are not in a neutral location the prestress steel shall not be released until the holes are patched and the patch material has attained a minimum compressive strength equal to the required release compressive strength or 28 MPa whichever is less.

The Contractor shall coat cored holes with a Type II, Grade 2 epoxy and patch the holes using the same type concrete as that in the girder, or a mix approved during the annual plant review and approval. The girder shall not be shipped until tests show the patch material has attained a minimum compressive strength of 28 MPa.

6-02.3(25)F Prestress Release

Side and flange forms that restrain deflection shall be removed before release of the prestressing reinforcement.

All harped and straight strands shall be released in a way that will produce the least possible tension in the concrete. This release shall not occur until tests show each girder has reached the minimum compressive strength required by the Plans.

The Contractor may request permission to release the prestressing reinforcement at a minimum concrete compressive strength less than specified in the Plans. This request shall be submitted to the Engineer for approval in accordance with Section 6-01.9 and shall be accompanied with calculations showing the adequacy of the proposed release concrete compressive strength. The release strength shall not be less than 24.5 MPa. The calculated release strength shall meet the requirements outlined in the Washington State Department of Transportation Bridge Design Manual for tension and compression at release. The proposed minimum concrete compressive strength at release will be evaluated by the Contracting Agency. Fabrication of girders using the revised release strength shall not begin until the Contracting Agency has provided written approval of the revised release compressive strength. If a reduction of the minimum concrete compressive strength at release is allowed, the Contractor shall bear any added cost that results from the change.

6-02.3(25)G Protection of Exposed Reinforcement

When a girder is removed from its casting bed, all bars and strands projecting from the girder shall be cleaned and painted with a minimum dry film thickness of 25.4 micrometers of paint Formula No. A-9-73. During handling and shipping, projecting reinforcement shall be protected from bending or breaking. Just before placing concrete around the painted projecting bars or strands, the Contractor shall remove from them all dirt, oil, and other foreign matter.

6-02.3(25)H Finishing

The Contractor shall apply a Class 1 finish, as defined in Section 6-02.3(14), to:

1. The exterior surfaces of the outside girders;
2. The bottoms, sides, and tops of the lower flanges on all girders; and

All other girder surfaces shall receive a Class 2 finish.

The interface on I-girders and other girders that contact the cast-in-place deck shall have a finish of dense, screeded concrete without a smooth sheen or laitance on the surface. After vibrating and screeding, and just before the concrete reaches initial set, the Contractor

shall texture the interface. This texture shall be applied with a steel brooming tool that etches the surface transversely leaving grooves 3 millimeters to 6 millimeters wide, between 3 millimeters and 6 millimeters deep, and spaced 6 millimeters to 13 millimeters apart.

On the deck bulb tee girder section, the Contractor shall test the roadway deck surface portion for flatness. This test shall occur after floating but while the concrete remains plastic. Testing shall be done with a 3-meter straightedge parallel to the girder centerline and with a flange width straightedge at right angles to the girder centerline. The Contractor shall fill depressions, cut down high spots, and refinish to correct any deviation of more than 6 millimeters within the straightedge length. This section of the roadway surface shall be finished to meet the requirements for finishing roadway slabs, as defined in Section 6-02.3(10).

The Contractor may repair rock pockets and other defects in the girder provided the repair is covered in the annual plant approval package. All other repairs and repair procedures shall be documented and approved by the Engineer prior to acceptance of the girder.

6-02.3(25)I Tolerances

The girders shall be fabricated as shown in the Plans and shall meet the dimensional tolerances listed below. Actual acceptance or rejection will depend on how the Engineer believes a defect outside these tolerances will affect the structure's strength or appearance.

1. Length (overall): ± 8 millimeters per 10 meters of beam length, up to a maximum of ± 25 millimeters
2. Width (flanges): + 10 mm, - 6 mm
3. Width (narrow web section): + 10 mm, - 6 mm
4. Girder Depth (overall): ± 6 mm
5. Flange Depth: + 6 mm, -3 mm
6. Strand Position: ± 6 mm from the center of gravity of a strand group and of an individual strand
7. Longitudinal Position of the Harping Point: ± 460 mm
8. Bearing Recess (center recess to beam end): ± 6 mm
9. Beam Ends (deviation from square or designated skew)
   Horizontal: ± 13 mm from web centerline to flange edge
   Vertical: ± 3 mm per foot of beam depth
10. Bearing Area Deviation from Plane (in length or width of bearing): 1.6 mm
11. Stirrup Reinforcing Spacing: ± 25 mm
12. Stirrup Projection from Top of Beam: ± 19 mm
13. Mild Steel Concrete Cover: - 3 mm, + 10 mm
14. Offset at Form Joints (deviation from a straight line extending 1.5 meters on each side of joint): ± 6 mm
15. Differential Camber Between Girders in a Span (measured in place at the job site)

For I-girders:	3 mm per 3 meters of beam length (Series W42MG, W50MG, W58MG, and W74MG, W83MG, and W95MG).
For deck bulb tee girders:	Cambers shall be equalized by an approved method when the difference in cambers between adjacent girders or stages measured at mid-span exceeds 6 mm.

16. Position of Inserts for Structural Connections: ± 13 mm
17. Position of Lifting Loops: ± 75 mm longitudinal, ± 25 mm transverse
18. Weld plates for bulb tee girders shall be placed ± 13 mm longitudinal, and ± 3 mm vertical

6-02.3(25)J Horizontal Alignment

The Contractor shall check and record the horizontal alignment of both top and bottom flanges of each girder upon removal of the girder from the casting bed. The Contractor shall also check and record the horizontal alignment within a two-week period prior to shipment, but no less than three days prior to shipment. If the girder remains in storage for a period exceeding 120 days, the Contractor shall check and record the horizontal alignment at approximately 120 days. Each check shall be made by measuring the distance between each flange and a chord that extends the full length of the girder. The Contractor shall perform and record each check at a time when the alignment of the girder is not influenced by temporary differences in surface temperature. These records shall be available for the Engineer's inspection and included in the Contractor's Prestressed Concrete Certificate of Compliance.

Immediately after the girder is removed from the casting bed, neither flange shall be offset more than 3 millimeters for each 3 meters of girder length. During storage and prior to shipping, the offset (with girder ends plumb and upright and with no external force) shall not exceed 6 millimeters per 3 meters of girder length. Any girder within this tolerance may be shipped, but must be corrected at the job site to the 3 millimeters maximum offset per 3 meters of girder length before concrete is placed into the diaphragms.

The Engineer may permit the use of external force to correct girder alignment at the plant or job site if the Contractor provides stress calculations and a proposed procedure. If external force is permitted, it shall not be released until after the roadway slab has been placed and cured ten days.

6-02.3(25)K Girder Deflection

The Contractor shall check and record the vertical deflection (camber) of each girder upon removal of the girder from the casting bed. If the girder remains in storage for a period exceeding 120 days, the Contractor shall check and record the vertical deflection (camber) within a two-week period prior to shipment, but no less than three days prior to shipment. The Contractor shall perform and record each check at a time when the alignment of the girder is not influenced by temporary differences in surface temperature. These records shall be available for the Engineer's inspection, and in the case of girders older than 120 days, shall be transmitted to the Engineer as soon as practical for evaluation of the effect of long-term storage on the "D" dimension. These records shall also be included in the Contractor's Prestressed Concrete Certificate of Compliance.

The "D" dimensions shown in the Plans are computed girder deflections at midspan based on a time elapse of 120 days after release of the prestressing strands. A positive (+) "D" dimension indicates upward deflection.

The Contractor shall control the deflection of prestressed concrete girders that are to receive a cast-in-place slab by scheduling fabrication within 120 days of girder erection. If it is anticipated that the girders will be older than 120 days at the time of erection, the Contractor shall submit calculations to the Engineer showing the estimated girder deflection at midspan at the age anticipated for erection. This submittal shall also include the Contractor's proposal for accommodating any excess camber in the construction. The Contractor shall not proceed with girder fabrication until this submittal is approved by the

Engineer. The actual girder deflection at the midspan may vary from the "D" dimension at the time of slab forming by a maximum of plus 13 millimeters for girder lengths up to 24.4 meters, plus 25 millimeters for girder lengths over 24.4 meters but less than or equal to 42.7 meters, and plus 38 millimeters for girder lengths over 42.7 meters.

All costs, including any additional Contracting Agency engineering expenses, in connection with accommodating excess girder deflection shall be at the Contractor's expense.

6-02.3(25)L Handling and Storage

During handling and storage, each girder shall always be kept plumb and upright. It shall be lifted only by the lifting devices (strand lift loops or high-strength threaded steel bars) at either end. For strand lift loops, a minimum 50 millimeter diameter straight pin of a shackle shall be used through the loops. For high-strength threaded steel bars, the lifting hardware that connects to the bars shall be designed, detailed, and furnished by the Contractor. Series W42MG, W50MG, and W58MG girders, and Series W74MG girders up to 44.2 meters in length, can be picked up at a minimum angle of 60 degrees from the top of the girder. All other prestressed girders shall be picked up within 10 degrees of perpendicular to the top of the girder.

For some girders, straight temporary top flange strands may be specified in the Plans. Pretensioned top temporary strands shall be unbonded over all but the end 3 meters of the girder length. As an alternative, temporary top strands may be post-tensioned prior to lifting the girder from the form. When the post-tensioned alternative is used, the Contractor shall be responsible for properly sizing the anchorage plates, and the reinforcement adjacent to the anchorage plates, to prevent bursting or splitting of the concrete in the top flange.

The Contractor may request permission to use lifting devices, lifting device locations, lifting angles, concrete release strengths, or temporary top strand configurations other than specified in the Plans. The number of temporary top strands may be increased from the number shown in the Plans but shall not be decreased. The request, including calculations showing the adequacy of the proposed lifting method, shall be submitted to the Engineer for approval in accordance with Section 6-01.9. The Contractor's analysis shall conform to Article 5.2.9 of the *PCI Design Handbook, Precast and Prestressed Concrete*, Fifth Edition, or other approved methods. The Contractor's calculations shall verify that the concrete stresses in the prestressed girder do not exceed those listed in Section 6-02.3(25)M. The Contractor shall not begin girder lifting operations under the provisions of the lifting method submittal until receiving the Engineer's written approval of the submittal, and shall perform the girder lifting operations at no additional expense to the Contracting Agency.

If girders are to be stored, the Contractor shall place them on a stable foundation that will keep them in a vertical position. Stored girders shall be supported at the bearing recesses or, if there are no recesses, approximately 460 millimeters from the girder ends. For long-term storage of girders with initial horizontal curvature, the Contractor may wedge one side of the bottom flange, tilting the girders to control curvature. If the Contractor elects to set girders out of plumb during storage, the Contractor shall have the proposed method analyzed by the Contractor's engineer to ensure against damaging the girder.

6-02.3(25)M Shipping

After the girder has reached its 28-day design strength, and the fabricator believes it to comply with the specification, the girder and a completed Certification of Compliance, signed by a Precast/Prestressed Concrete Institute Certified Technician or a professional engineer, acceptable to the Contracting Agency, shall be submitted to the Engineer for inspection. If the Engineer finds the certification and the girder to be acceptable, the Engineer will stamp the girder "Approved for Shipment."

No prestressed girders shall be shipped that are not stamped "Approved for Shipment."

No bulb tee girder shall be shipped for at least seven days after concrete placement. No other girder shall be shipped for at least ten days after concrete placement.

Girder support during shipping shall be located as follows unless otherwise shown in the Plans:

Type of Girder	Centerline Support This Distance From Both Ends
Series W42MG and W50MG and all bulb tee girders	0.9 meters
Series W58MG	1.2 meters
Series W74MG	1.5 meters
Series W83MG and W95MG	2.44 meters

The Contractor may request permission to use support locations other than those specified. The Contractor shall submit the support location modification proposal, with supporting calculations, to the Engineer for approval in accordance with Section 6-01.9. If the support locations are moved closer to the ends of the girders, the calculations shall demonstrate adequate control of lateral bending during shipping. The calculations shall also show that concrete stresses in the girders will not exceed those listed below:

Girder lengths equal or shorter than the following shall not require lateral bracing for shipping:

Type of Girder	Maximum Length Not Requiring Bracing for Shipping
Series W42G	24.4 meters
Series W50G	30.5 meters
Series W58G	32.0 meters
All bulb tee girders	36.5 meters
Series W74G	39.6 meters

For all girders exceeding these lengths, and all Series W83G and W95G girders, the Contractor shall provide bracing to control lateral bending during shipping, unless the Contractor furnishes calculations in accordance with Section 6-01.9 demonstrating that bracing is not necessary. External bracing shall be attached securely to the top flange of the girder. The Contractor is cautioned that more conservation guidelines for lateral bracing may be required for some delivery routes. The Contractor shall submit a bracing plan, with supporting calculations, to the Engineer for approval in accordance with Section 6-01.9. The Contractor shall not begin shipping the girders until receiving the Engineer's approval of the bracing plan, and shall perform all bracing operations at no additional cost to the Contracting Agency.

Criteria for Checking Girder Stresses at the Time of Lifting or Transporting and Erecting

Stresses at both support and harping points shall be satisfied based on these criteria:

1. Allowable compression stress, fc = 0.60 f′cm
   a. f′cm = compressive strength at time of lifting or transporting verified by test but shall not exceed design compressive strength (f′c) at 28 days in MPa + 7 MPa
2. Allowable tension stress, ft
   a. With no bonded reinforcement = 0.249 $\sqrt{f'cm}$
   b. With bonded reinforcement to resist total tension force in the concrete computed on the basis of an uncracked section = 0.623 $\sqrt{f'cm}$. The allowable tensile stress in reinforcement is 210 MPa (AASHTO M-31, Gr. 60)
3. Prestress losses
   a. 1 day to 1 month = 140 MPa
   b. 1 month to 1 year = 240 MPa
   c. 1 year or more = 310 MPa (max.)
4. Impact on dead load
   a. Lifting from casting beds = 0 percent
   b. Transporting and erecting = 20 percent

6-02.3(25)N Prestressed Concrete Girder Erection

Before beginning to erect any prestressed concrete girders, the Contractor shall submit to the Engineer for review and shall have received approval for the erection plan and procedure describing the methods the Contractor intends to use. The erection plan and procedure shall provide complete details of the erection process including but not limited to:

1. Temporary falsework support, bracing, guys, deadmen, and attachments to other structure components or objects;
2. Procedure and sequence of operation;
3. Girder stresses during progressive stages of erection;
4. Girder masses, lift points, lifting devices, spreaders, and angle of lifting cables in accordance with Section 6-02.3(25)L, etc.;
5. Crane(s) make and model, mass, geometry, lift capacity, outrigger size and reactions;
6. Girder launcher or trolley details and capacity (if intended for use); and
7. Locations of cranes, barges, trucks delivering girders, and the location of cranes and outriggers relative to other structures, including retaining walls and wing walls.

The erection plan shall include drawings, notes, catalog cuts, and calculations clearly showing the above listed details, assumptions, and dimensions. Material properties and specifications, structural analysis, and any other data used shall also be included. The plan shall be prepared by (or under the direct supervision of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural, and shall carry the engineer's seal and signature, in accordance with Section 6-02.3(16).

The Contractor shall submit the erection plans, calculations, and procedure directly to the Bridge and Structures Office, Construction Support Engineer, in accordance with Section 6-02.3(16). After the plan is approved and returned to the Contractor, all changes that the Contractor proposes shall be submitted to the Engineer for review and approval.

When prestressed girders arrive on the project, the Project Engineer will confirm that they are stamped "Approved for Shipment" and that they have not been damaged in shipment before accepting them.

The concrete in piers and crossbeams shall reach at least 80 percent of design strength before girders are placed on them. The Contractor shall hoist girders only by the lifting devices at the ends, always keeping the girders plumb and upright. Once erected, the girders shall be braced to prevent tipping until the intermediate diaphragms are cast and cured. **When temporary strands in the top flange are used, they shall be cut after all intermediate diaphragms are cast and cured, but before the cast-in-place deck is placed**.

Instead of the oak block wedges shown in the Plans, the Contractor may use Douglas fir blocks if the grain is vertical.

Before the grout pads are placed, the concrete beneath them shall be thoroughly cleaned, roughened, and wetted with water to ensure proper bonding. Pads shall be kept wet continuously until they reach a compressive strength of at least 14 megapascals. Grout pads shall reach this strength before girders are set on them. Grout compressive strength will be determined by fabricating cubes in accordance with WSDOT Test Method 813 and testing in accordance with AASHTO T-106.

The Contractor shall check the horizontal alignment of both the top and bottom flanges of each girder before placing concrete in the bridge diaphragms as described in Section 6-02.3(25)J.

The Contractor shall fill all block-out holes and patch any damaged area caused by the Contractor's operation, with an approved mix, to the satisfaction of the Engineer.

6-02.3(25)O Deck Bulb Tee Girder Flange Connection

The Contractor shall submit a method of equalizing deck bulb tee girder deflections to the Engineer for approval. This submittal shall be prepared by, or under the direction of, a professional engineer licensed under Title 18 RCW, State of Washington, and shall carry the engineer's signature and seal. This submittal shall be made a minimum of 60 days prior to field erection of the deck bulb tee girder. Deflection equalizing methods approved for previous Contracting Agency contracts will be acceptable providing the bridge configuration is similar and the previous method was satisfactory. A listing of the previous Contracting Agency contract numbers for which the method was used shall be included with the submittal.

On deck bulb tee girders, girder deflection shall be equalized utilizing the approved method before girders are weld-tied and before keyways are filled. Keyways between tee girders shall be filled flush with the surrounding surfaces with nonshrink grout. This nonshrink grout shall have a compressive strength of 28 megapascals before the equalizing equipment is removed. Compressive strength shall be determined by fabricating cubes in accordance with WSDOT Test Method 813 and testing in accordance with AASHTO T-106.

Welding grounds shall be attached directly to the steel plates being welded when welding the weld-ties on bulb tee girders.

No construction equipment shall be placed on the structure, other than equalizing equipment, until the girders have been weld-tied and the keyway grout has attained a compressive strength of 28 megapascals.

6-02.3(26) Cast-in-Place Prestressed Concrete

Cast-in-place prestressed concrete shall be Class 28 mix (unless the Plans show otherwise). It shall be air-entrained, but shall not contain air-entraining cement.

The Contractor shall construct supporting falsework in a way that leaves the superstructure free to contract and lift off the falsework during post-tensioning. Forms that will remain inside box girders to support the roadway slab shall, by design, resist girder contraction as little as possible.

Before tensioning, the Contractor shall remove all side forms from girders. From this point until 48 hours after grouting the tendons, the Contractor shall keep all construction and other live loads off the superstructure and shall keep the falsework supporting the superstructure in place.

Once the prestressing steel is installed, no welds or welding grounds shall be attached to metal forms, structural steel, or reinforcing bars of the structural member.

The Contractor shall not stress the strands until all concrete has reached a compressive strength of at least 28 megapascals (or the strength shown in the Plans). This strength shall be measured on concrete test cylinders made of the same concrete cured under the same conditions as the cast-in-place unit.

All post-tensioning shall be completed before sidewalks and barriers are placed.

6-02.3(26)A Shop Drawings

Before casting the structural elements, the Contractor shall submit:

1. Seven sets of shop drawings for approval by the Bridge and Structures Engineer:

US Postal Service:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340

Fedex:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

2. Two sets of shop drawings to the Project Engineer.

These shop drawings shall show complete details of the methods, materials, and equipment the Contractor proposes to use in prestressing work. The shop drawings shall follow the design conditions shown in the Plans unless the Engineer permits equally effective variations.

In addition, the shop drawings shall show:

1. The method and sequence of stressing.
2. Technical data on tendons and steel reinforcement, anchoring devices, anchoring stresses, types of tendon conduit, and all other data on prestressing operations.

3. Stress and elongation calculations. Separate stress and elongation calculations shall be submitted for each tendon if the difference in tendon elongations exceeds 2 percent.
4. That tendons in the bridge will be arranged to locate their center of gravity as the Plans require.
5. Details of additional or modified reinforcing steel required by the stressing system.
6. Procedures and lift-off forces at both ends of the tendon for performing a force verification lift-off in the event of discrepancies between measured and calculated elongations.

Couplings or splices will not be permitted in prestressing strands. Couplings or splices in bar tendons are subject to the Engineer's approval.

Friction losses used to calculate forces of the post-tensioning steel shall be based on the assumed values used for the design. The assumed anchor set, friction coefficient "μ," and friction wobble coefficient "k" values for design are shown in the Plans. The post-tensioning supplier may revise the assumed anchor set value provided all the stress and force limits listed in Section 6-02.3(26)E are met.

The Contractor shall determine all points of interference between the mild steel reinforcement and the paths of the post-tensioning tendons. Details to resolve interferences shall be submitted with the shop drawings for approval. Where reinforcing bar placement conflicts with post-tensioning tendon placement, the tendon profile shown in the Plans shall be maintained. Mild steel reinforcement for post-tensioning anchorage zones shall not be fabricated until after the post-tensioning shop drawings have been approved by the Engineer.

Approval of these shop drawings will mean only that the Engineer considers them to show a reasonable approach in enough detail. Approval will not indicate a check on dimensions.

The Contractor may deviate from the approved shop drawings only after obtaining the Engineer's approval of a written request that describes the proposed changes. Approval of a change in method, material, or equipment shall not relieve the Contractor of any responsibility for completing the work successfully.

Before physical completion of the project, the Contractor shall provide the Engineer with reproducible originals of the shop drawings (and any approved changes). These shall be clear, suitable for microfilming, and on permanent sheets that measure 560 mm by 865 mm.

6-02.3(26)B Anchorages

Post-tensioning reinforcement shall be secured at each end by means of an approved anchorage device which shall be of such a nature that it will not kink, neck down, or otherwise damage the post-tensioning reinforcement. The anchorage assembly shall be grouted to the Engineer's satisfaction.

The structure shall be reinforced with steel reinforcing bars in the vicinity of the anchorage device. This reinforcement is categorized into two zones. The first or local zone is the anchorage region that closely surrounds the specific anchorage device. The second or general zone is the portion of the anchorage region more remote from the immediate anchorage device.

The steel reinforcing bars required locally for the concrete confinement immediately around the anchorage device (first or local zone) shall be calculated by the post-tensioning system supplier and shall be shown in the shop drawings. The calculations shall be

submitted with the shop drawings. The first or local zone steel reinforcing bars shall be furnished and installed by the Contractor, at no additional cost to the State, in addition to the structural reinforcement required by the Plans. The steel reinforcing bars required in the second or general zone shall be as shown in the Plans and are included in the appropriate bid items.

The Contractor shall submit details, certified test reports, and/or supporting calculations, as specified below, which verify the structural adequacy of the anchorage devices for approval by the Engineer. This requirement does not apply where the anchorage devices have been previously approved by the Contracting Agency for the same structure configuration. The Contractor shall also submit any necessary changes to the Contract Plans. The test report shall specify all pertinent test data. Dead ended anchorages will not be permitted. Dead ended anchorages are defined as anchorages that cannot be accessed during the stressing operations.

The Contractor's proposed anchorage devices shall meet the requirements listed in 1 or 2 below:

1. Bearing Type Anchorage:
   a. The computed average bearing stress on the concrete directly beneath bearing plates shall not exceed either of the following:
      (1) At service load (after all losses) —

$$fcp = 0.6\, f'c\, (A'b/Ab)^{1/2}$$

but not greater than 1.25 f′c

      (2) At jacking load (before seating) —

$$fcp = 0.8\, f'ci\, (A'b/Ab - 0.2)^{1/2}$$

but not greater than 1.25 f′ci for longitudinal tendons anchored in the webs, and not greater than 1.00 f′ci for transverse tendons anchored in the deck slab, where:

fcp = permissible compressive concrete stress,
f′c = compressive strength of concrete,
f′ci = compressive strength of concrete at time of initial prestress,
A′b = maximum area of the portion of the concrete anchorage surface that is geometrically similar to and concentric with the area of the anchorage (excluding openings),
Ab = bearing area of the anchorage excluding openings.

   b. For anchorages where A′b and Ab are equal, and in transverse post-tensioning of roadway slabs, the bearing stress shall not exceed 0.9f′c at jacking load (before seating) or 20 megapascals at service load after all losses.
   c. The computed bending stresses in the distribution plate induced by the pull of the prestressing steel shall not exceed 90 percent of the yield point of the material when 95 percent of the ultimate strength of the post-tensioning reinforcement is applied. The bending stresses in the distribution plate shall be computed in accordance with the procedure described in the article titled "Simplified Bearing Plate Computations for Post-Tensioning Anchorages" published in the July-August 1975 edition of the PCI Journal, and these calculations shall be submitted with the shop plans for approval.

d. Materials and workmanship shall conform to the applicable requirements of Sections 6-03 and 9-06.

2. Other Anchorage Assemblies:

Other anchorage assemblies shall be defined as an assembly that does not meet the requirements of item 1.a. above for bearing type anchorages. The adequacy of other anchorage assemblies shall be demonstrated by tests representing actual job site conditions. The tests shall be certified and meet the following requirements:

a. The concrete test block shall have a cross-section equal to twice the minimum edge distance of centerline of tendon to the face of concrete in the actual structure in one direction and equal to the minimum spacing of the anchorages plus 75 millimeters in the other direction. The length of the concrete test block shall be at least three times the largest cross-section dimension.

b. The reinforcement in the test block behind the anchorage for a distance equal to the largest of the two cross-sectional dimensions of the anchorage shall simulate the actual reinforcement used in the structure. For the remaining length of the test block, the reinforcement may be increased as required to prevent failure in that portion.

c. Concrete strength at the time of testing shall not exceed 85 percent of the minimum concrete strength at the time of post-tensioning as specified in the Plans. The concrete strength shall be determined in accordance with procedures as outlined in ASTM C 1074, Estimating Concrete Strength by the Maturity Method.

d. The test shall be comprised of three anchorages separately tested or tested together in one test block.

e. Anchorages shall be capable of developing 95 percent of the ultimate strength of the post-tensioning reinforcement without measurable permanent distortion of the assembly and without concrete failure in the test block. Measurably permanent distortion is defined as a distortion across the face of the assembly of 0.3 millimeter or more using the original plane as a reference and is measured after the test loading is released. The test block shall be acceptable with regard to concrete failure if the following criteria are satisfied:

(1) No concrete cracks with a load of 40 percent of the ultimate strength of the post-tensioning reinforcement.

(2) Width of concrete cracks with a test load of 70 percent of the ultimate strength of the post-tensioning reinforcement does not exceed 0.1 millimeter.

(3) After loading to 95 percent of the ultimate strength of the post-tensioning reinforcement and releasing the test load, the width of concrete cracks does not exceed 0.4 millimeter.

f. Materials and workmanship shall conform to the applicable requirements of Sections 6-03 and 9-06.

Before installing the anchorage device, the Contractor shall submit a Manufacturer's Certificate of Compliance for the anchorage device in accordance with Section 1-06.3.

6-02.3(26)C Metal Ducts

The Contractor shall encase each tendon in a galvanized, ferrous metal duct that is rigid and spiral. This duct shall maintain the required profile within a placement tolerance of plus or minus 6 millimeters for longitudinal tendons and plus or minus 3 millimeters for transverse slab tendons during all phases of the work. The ducts shall be completely sealed to keep out all mortar.

Each duct shall be located to place the tendon at the center of gravity the Plans require. To keep friction losses to a minimum, the Contractor shall install ducts to the exact lines and grades shown in the Plans. Once in place, the ducts shall be tied firmly in position before they are covered with concrete. During concrete placement, the Contractor shall not displace or damage the ducts.

The ends of the ducts shall:

1. Permit free movement of anchorage devices, and
2. Remain covered after installation in the forms to keep out all water or debris.

The Contractor shall install vents at high points and drains at low points of the tendon profile (and at other places if the Plans require). Vents and drains shall be 13 millimeters minimum diameter standard steel or polyethylene pipe. Vents shall point upward and remain closed until grouting begins. Drains shall point downward and remain open until grouting begins. Ends of steel vents and drains shall be removed 25 millimeters inside the concrete surface after grouting has been completed; polyethylene vents and drains may be left flush to the surface unless otherwise directed by the Engineer. Conduit vents are not required for transverse post-tensioning ducts in the roadway slab unless specified in the Plans.

Immediately after any concrete placement, the Contractor shall force blasts of oil-free, compressed air through the ducts to break up and remove any mortar inside before it hardens. Before deck concrete is placed, the Contractor shall satisfy the Engineer that ducts are unobstructed and contain nothing that could interfere with grouting or harm the tendons. If the tendons are in place, the Contractor shall show that they are free in the duct.

In temperatures below 0°C, ducts shall be kept free from water to avoid damage from freezing.

6-02.3(26)D Prestressing Reinforcement

All prestressing reinforcement shall comply with Section 9-07.10. They shall not be coupled or spliced. Tendon locations shown in the Plans indicate final positions after stressing (unless the Plans say otherwise). No tendon made of 7 wire strands shall contain more than 31 strands of 12.70-millimeter diameter, or more than 22 strands of 15.24-millimeter diameter.

From the time prestressing reinforcement is made until it is grouted or encased in concrete, the Contractor shall protect it from dirt, grease, rust, corrosives, and all physical damage. The Engineer will reject prestressing reinforcement that shows any sign of damage, rust, or corrosion. If the prestressing reinforcement will not be stressed and grouted for more than ten calendar days after it is placed in the ducts, the Contractor shall place an approved corrosion inhibitor in the ducts.

The feeding ends of the strands shall be equipped with a bullet nosing or similar apparatus to facilitate strand installation.

6-02.3(26)E Tensioning

The Contractor shall not begin to tension the tendons until:

1. All concrete has reached a compressive strength of at least 28 megapascals or the strength the Plans require (demonstrated on test cylinders made of the same concrete cured under the same conditions as that in the bridge), and
2. The Engineer is satisfied that all strands are free in the ducts.

Tendons shall be tensioned to the values shown in the Plans (or approved shop drawings) with hydraulic jacks. When stressing from both ends of a tendon is specified, it need not be simultaneous unless the Plans require. The jacking sequence shall follow the approved shop drawings.

Each jack shall have a pressure gauge that will determine the load applied to the tendon. The gauge shall display pressure accurately and readably with a dial at least 150 millimeters in diameter or with a digital display. Each jack and its gauge shall be calibrated as a unit and shall be accompanied by a certified calibration chart. The Contractor shall provide one copy of this chart to the Engineer for use in monitoring. The cylinder extension during calibration shall be in approximately the position it will occupy at final jacking force.

All jacks and gauges must be recalibrated and recertified: (1) at least every 180 days, and (2) after any repair or adjustment. The Engineer may use pressure cells to check jacks, gauges, and calibration charts before and during tensioning.

These stress limits apply to all tendons (unless the Plans set other limits):

1. Maximum service load after all losses: 80 percent of the specified yield point stress of the steel.
2. Maximum tensile stress during jacking: 79 percent of the specified minimum ultimate tensile strength of the steel.
3. Maximum initial stress at anchorage after seating: 70 percent of the specified minimum ultimate tensile strength of the steel.

Tendons shall be anchored at initial stresses that will ultimately maintain service loads at least as great as the Plans require.

As stated in Section 6-02.3(26)A, the assumed design friction coefficient "μ" and wobble coefficient "k" shown in the Plans shall be used to calculate the stressing elongation. These coefficients may be revised by the post-tensioning supplier by the following method provided it is approved by the Engineer:

Early in the project, the post-tensioning supplier shall test, in place, two representative tendons of each size and type shown in the Plans, for the purpose of accurately determining the friction loss in a strand and/or bar tendon.

The test procedure shall consist of stressing the tendon at an anchor assembly with load cells at the dead end and jacking end. The test specimen shall be tensioned to 79 percent of ultimate in ten increments. For each increment, the gauge pressure, elongation, and load cell force shall be recorded and the data furnished to the Engineer. The theoretical elongations and post-tensioning forces shown on the post-tensioning shop drawings shall be re-evaluated by the post-tensioning supplier using the results of the tests and corrected as necessary. Revisions to the theoretical elongations shall be submitted to the Engineer for evaluation and approval. The apparatus and methods used to perform the tests shall be proposed by the post-tensioning supplier and be subject to the approval of the Engineer.

All costs associated with testing and evaluating test data shall be included in the unit contract prices for the applicable items of work involved.

As tensioning proceeds, the Engineer will be recording the applied load, tendon elongation, and anchorage seating values.

Elongation measurements shall be made at each stressing location to verify that the tendon force has been properly achieved. If proper anchor set has been achieved and the measured elongation of each strand tendon is within plus or minus 7 percent of the approved calculated elongation, the stressed tendon represented by the elongation measurements is acceptable to the state.

In the event discrepancies greater than 7 percent exist between the measured and calculated elongations, the jack calibration shall be checked and stressing records reviewed for any evidence of wire or strand breakage. If the jack is properly calibrated and there is no evidence of wire or strand breakage, a force verification lift off shall be performed to verify the force in the tendon. The post-tensioning supplier force verification lift off procedure shall provide access for visual verification of anchor plate lift off. The jacking equipment shall be capable of bridging and lifting off the anchor plate. The tendon is acceptable if the verification lift off force is not less than 99 percent of the approved calculated force nor more than 70 percent of the specified minimum ultimate tensile strength of the prestressing steel or as approved by the Engineer.

Elongation measurements shall be recorded for bar tendons to verify proper tensioning only. Acceptance will be by force verification lift off. The bar tendon is acceptable if the verification lift off force is not less than 95 percent nor more than 105 percent of the approved calculated force or as approved by the Engineer.

When removing the jacks, the Contractor shall relieve stresses gradually before cutting the prestressing reinforcement. The prestressing strands shall be cut a minimum of 25 millimeters from the face of the anchorage device.

6-02.3(26)F Grouting

After tensioning the tendons, the Contractor shall again blow oil-free, compressed air through each duct. All drains shall then be closed and the vents opened. After completely filling the duct with grout, the Contractor shall pump the grout from the low end at a pressure of not more than 1700 kilopascal (gauge), except for transverse tendons in deck slabs the grout pressure shall not exceed 700 kilopascal (gauge). Grout shall be continuously wasted through the vent until no more air or water pockets show. At this point, all vents shall be closed and grouting pressure at the injector held between 700 kilopascal (gauge) and 1400 kilopascal (gauge) for at least 10 seconds, except for transverse tendons in deck slabs the grouting pressure shall be held between 350 kilopascal (gauge) and 525 kilopascal (gauge) for at least 10 seconds. The Contractor shall leave all plugs, caps, and valves in place and closed for at least 24 hours after grouting.

Grouting equipment shall:

1. Include a pressure gauge with an upper end readout of between 1900 kilopascal (gauge) and 2250 kilopascal (gauge);
2. Screen the grout before it enters the pump with an easily reached screen that has clear openings of no more than 3 millimeters;
3. Be gravity fed from an attached, overhead hopper kept partly full during pumping; and
4. Be able to complete the largest tendon on the project in no more than 20 minutes of continuous grouting.

In addition, the Contractor shall have standby equipment (with a separate power source) available for flushing when the regular equipment cannot maintain a one-way flow of grout. This standby equipment shall be able to pump at 1700 kilopascal (gauge).

The grout shall consist of Portland cement, water, and a water reducing admixture and shall be mixed in the following proportions:

Portland Cement Type I or II	1 Sack
Water	17 Liters Maximum
Water Reducing Admixture	Manufacturer's Recommendation
Fly Ash (Optional)	9 Kilograms Maximum

The water reducing admixture shall be limited to AASHTO M 194 Type A or D and shall not contain ingredients that may corrode steel (that is chlorides, fluorides, sulfates, or nitrates). Fly ash may be used at the option of the Contractor.

The Contractor shall proportion the mix to produce a grout with a flow of 15 to 20 seconds as determined by ASTM C 939, Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method). The grout ejected from the end vent shall have a minimum flow of 15 seconds.

The grout mix shall be injected within 30 minutes after the water is added to the cement. Temperature of the surrounding concrete shall be at least 2°C from the time the grout injecting begins until 50-millimeter cubes of the grout have a compressive strength of 6 megapascals. Cubes shall be made in accordance with WSDOT Test Method 813 and stored in accordance with method 2 of Field Operating Procedure for AASHTO T 23. If ambient conditions are such that the surrounding concrete temperature may fall below 2°C, the Contractor shall provide a heat source and protective covering for the structure to keep the temperature of the surrounding concrete above 2°C. Grout temperature shall not exceed 32°C during mixing and pumping. If conditions are such that the temperature of the grout mix may exceed 32°C, the Contractor will make necessary provisions, such as cooling the mix water and/or dry ingredients, to ensure that the temperature of the grout mix does not exceed 32°C.

6-02.3(27) Concrete for Precast Units

Precast units shall not be removed from forms until the concrete has attained a minimum compressive strength of 70 percent of the specified design strength as verified by rebound number determined in accordance with ASTM C 805.

Precast units shall not be shipped until the concrete has reached the specified design strength as determined by testing cylinders made from the same concrete as the precast units. The cylinders shall be made, handled, and stored in accordance with Field Operating Procedure for AASHTO T 23 Method 2 and compression tested in accordance with AASHTO T 22 and T 231.

6-02.3(28) Precast Concrete Panels

The Contractor shall perform quality control inspection. The manufacturing plant for precast concrete units shall be certified by the Precast/Prestressed Concrete Institute's Plant Certification Program for the type of precast member to be produced and shall be approved by WSDOT as a Certified Precast Concrete Fabricator prior to the start of production. WSDOT Certification will be granted at, and renewed during, the annual precast plant review and approval process. Products which shall conform to this requirement include noise barrier panels, wall panels, floor and roof panels, marine pier deck panels, retaining walls, pier caps, and bridge deck panels.

Prior to the start of production of the precast concrete units, the Contractor shall advise the Engineer of the production schedule. The Contractor shall give the Inspector safe and free access to the work. If the Inspector observes any nonspecification work or unacceptable quality control practices, the Inspector will advise the plant manager. If the corrective action is not acceptable to the Engineer, the unit(s) will be rejected.

The Contracting Agency intends to perform Quality Assurance Inspection. By its inspection, the Contracting Agency intends only to facilitate the work and verify the quality of that work. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

If products are prestressed, all prestressing materials and methods shall be in accordance with Section 6-02.3(25).

6-02.3(28)A Shop Drawings

Before casting the structural elements, the Contractor shall submit:

1. Seven sets of shop drawings for approval by the Bridge and Structures Engineer, Department of Transportation, Transportation Building, Olympia, WA 98504; and
2. Two sets of shop drawings to the Project Engineer.

These shop drawings shall show complete details of the methods, materials, and equipment the Contractor proposes to use in prestressing/precasting work. The shop drawings shall follow the design conditions shown in the Plans unless the Engineer approves equally effective variations.

The shop drawings shall contain as a minimum:

1. Unit shapes (elevations and sections) and dimensions.
2. Finishes and method of constructing the finish (i.e., forming, rolling, etc.).
3. Reinforcing, joint, and connection details.
4. Lifting, bracing, and erection inserts.
5. Locations and details of hardware attached to the structure.
6. Relationship to adjacent material.

Approval of these shop drawings shall not relieve the Contractor of responsibility for accuracy of the drawings or conformity with the Contract. Approval will not indicate a check on dimensions.

The Contractor may deviate from the approved shop drawings only after obtaining the Engineer's approval of a written request that describes the proposed changes. Approval of a change in method, material, or equipment shall not relieve the Contractor of any responsibility for completing the work successfully.

Before completion of the Contract, the Contractor shall provide the Engineer with reproducible originals of the shop drawings (and any approved changes). These shall be clear, suitable for microfilming, and on permanent sheets that conform with the size requirements of Section 6-01.9.

6-02.3(28)B Casting

Before casting precast concrete units, the Contractor and Fabrication Inspector shall have possession of an approved set of shop drawings.

Precast units shall not be removed from forms until the concrete has attained a minimum compressive strength of 70 percent of the specified design strength. A minimum compressive strength at other than 70 percent may be used for specific precast units if the fabricator requests and receives approval as part of the WSDOT plant certification process.

Forms may be steel or plywood faced, providing they impart the required finish to the concrete.

6-02.3(28)C Curing

Concrete in the precast units shall be cured by either moist or accelerated curing methods. The methods to be used shall be preapproved in the WSDOT plant certification process.

1. For moist curing, the surface of the concrete shall be kept covered or moist until such time as the compressive strength of the concrete reaches the strength specified for stripping. Exposed surfaces shall be kept continually moist by fogging, spraying, or covering with moist burlap or cotton mats. Moist curing shall commence as soon as possible following completion of surface finishing.
2. For accelerated curing, heat shall be applied at a controlled rate following the initial set of concrete in combination with an effective method of supplying or retaining moisture. Moisture may be applied by a cover of moist burlap, cotton matting, or other effective means. Moisture may be retained by covering the unit with an impermeable sheet.

Heat may be radiant, convection, conducted steam or hot air. Heat the concrete to no more than 38 C during the first two hours after pouring the concrete, and then increase no more than 4 C per hour to a maximum of 79 C. After curing is complete, cool the concrete no more than -4 C per hour to 38 C. Maintain the concrete temperature above 16 C until the unit reaches stripping strength.

Concrete temperature shall be monitored by means of a thermocouple embedded in the concrete (linked with a thermometer accurate to plus or minus 3 C). The recording sensor (accurate to plus or minus 3 C) shall be arranged and calibrated to continuously record, date, and identify concrete temperature throughout the heating cycle. This temperature record shall be made available to the Engineer for inspection and become a part of the documentation required.

The Contractor shall never allow dry heat to directly touch exposed unit surfaces at any point.

6-02.3(28)D Contractors Control Strength

The concrete strength at stripping and the verification of design strength shall be determined by testing cylinders made from the same concrete as the precast units. The cylinders shall be made, handled, and stored in accordance with Field Operating Procedure for AASHTO T 23 Method 2 and compression tested in accordance with AASHTO T 22 and T 231.

For accelerated cured units, concrete strength shall be measured on test cylinders cast from the same concrete as that in the unit. These cylinders shall be cured under time-temperature relationships and conditions that simulate those of the unit. If the forms are heated by steam or hot air, test cylinders will remain in the coolest zone throughout curing. If forms are heated another way, the Contractor shall provide a record of the curing time-temperature relationship for the cylinders for each unit to the Engineer. When two or more units are cast in a continuous line and in a continuous pour, a single set of test cylinders may represent all units provided the Contractor demonstrates uniformity of casting and curing to the satisfaction of the Engineer.

The Contractor shall mold, cure, and test enough of these cylinders to satisfy specification requirements for measuring concrete strength. The Contractor may use 100-millimeter by 200-millemeter or 150-millemeter by 300-millimeter cylinders. The Contractor shall let cylinders cool for at least one-half hour before testing for release strength.

Test cylinders may be cured in a moist room or water tank in accordance with AASHTO T-23 after the unit concrete has obtained the required release strength. If, however, the Contractor intends to ship the unit prior to standard 28-day strength test, the design strength for shipping shall be determined from cylinders placed with the unit and cured under the same conditions as the unit. These cylinders may be placed in a noninsulated, moisture-proof envelope.

To measure concrete strength in the precast unit, the Contractor shall randomly select two test cylinders and average their compressive strengths. The compressive strength in either cylinder shall not fall more than 5 percent below the specified strength. If these two cylinders do not pass the test, two other cylinders shall be selected and tested.

6-02.3(28)E Finishing

The Contractor shall provide a finish on all relevant concrete surfaces as defined in Section 6-02.3(14), unless the Plans or Special Provisions require otherwise.

6-02.3(28)F Tolerances

The units shall be fabricated as shown in the Plans, and shall meet the dimensional tolerances listed in PCI MNL-116-85, unless otherwise required by the Plans or Special Provisions.

6-02.3(28)G Handling and Storage

The Contractor shall lift all units only by adequate devices at locations designated on the shop drawings. When these devices and locations are not shown in the Plans, Section 6-02.3(25)L shall apply.

Precast units shall be stored off the ground on foundations suitable to prevent differential settlement or twisting of the units. Stacked units shall be separated and supported by dunnage of uniform thickness capable of supporting the units. Dunnage shall be arranged in vertical planes. The upper units of a stacked tier shall not be used as storage areas for shorter units unless substantiated by engineering analysis and approved by the Engineer.

6-02.3(28)H Shipping

Precast units shall not be shipped until the concrete has reached the specified design strength. The units shall be supported in such a manner that they will not be damaged by anticipated impact on their dead load. Sufficient padding material shall be provided between tie chains and cables to prevent chipping or spalling of the concrete.

6-02.3(28)I Erection

When the precast units arrive on the project, the Project Engineer will confirm that they are stamped "Approved for Shipment." The Project Engineer will evaluate the present units for damage before accepting them.

The Contractor shall lift all units by suitable devices at locations designated on the shop drawings. Temporary shoring or bracing shall be provided, if necessary. Units shall be properly aligned and leveled as required by the Plans. Variations between adjacent units shall be leveled out by a method approved by the Engineer.

6-02.4 Measurement

Except as noted below, all classes of concrete shall be measured in place by the cubic meter to the neat lines of the structure as shown in the Plans.

Exception: concrete in cofferdam seals. Payment for Class 28W concrete used in these seals will be based on the actual volume deposited. This volume will be calculated by the average cross-sectional area inside the cofferdam. No payment will be made for any concrete that lies:

1. Above the top or below the bottom of the neat lines of the seal, or
2. More than 0.3 meter outside the neat lines of the sides of the seal.

Exception: concrete in a separate lump-sum, superstructure bid item. Any concrete quantities noted under this item in the Special Provisions will not be measured. Although the Special Provisions list approximate quantities for the Contractor's convenience, the Contracting Agency does not guarantee the accuracy of these estimates. Before submitting a bid, the Contractor shall have verified the quantities. Even though actual quantities used may vary from those listed in the Special Provisions, the Contracting Agency will not adjust the lump sum contract price for superstructure (except for approved changes).

The Contracting Agency will pay for no concrete placed below the established elevation of the bottom of any footing or seal.

Lean concrete will be measured by the cubic meter for the quantity of material placed per the producer's invoice, except that lean concrete included in other contract items will not be measured.

No deduction will be made for pile heads, reinforcing steel, structural steel, bolts, weep holes, rustications, chamfers, edgers, joint filler, junction boxes, miscellaneous hardware, ducts or less than 150-millimeter diameter drain pipes when computing concrete quantities for payment.

All reinforcing steel will be measured by the computed mass of all metal actually in place and required by the Plans or the Engineer. Epoxy-coated bars will be measured before coating. The Contractor shall furnish (without extra allowance):

1. Spreaders, form blocks, wire clips, and other fasteners.
2. Extra steel in splices not shown in the Plans.
3. Extra shear steel at construction joints not shown in the Plans when the Engineer permits such joints for the Contractor's convenience.

The following table shall be used to compute mass of reinforcing steel:

Steel Reinforcing Bar

Deformed Bar Designation Number	Nominal Diameter Millimeters	Unit Mass Kilograms per Meter
3	9.5	0.560
4	12.7	0.994
5	15.9	1.552
6	19.1	2.235
7	22.2	3.045
8	25.4	3.973
9	28.7	5.060
10	32.3	6.404
11	35.8	7.907
14	43.0	11.38
18	57.3	20.24

Gravel backfill will be measured as specified in Section 2-09.4.

6-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Conc. Class ____", per cubic meter.

"Commercial Concrete", per cubic meter.

All concrete, except in Superstructure when this is covered by a separate bid item, will be paid for at the unit contract price per cubic meter in place for the various classes of concrete.

"Superstructure (name bridge)", lump sum.

All costs in connection with providing holes for vents, for furnishing and installing cell drainage pipes for box girder structures, and furnishing and placing grout and shims under steel shoes shall be included in the unit contract prices for the various bid items involved.

All costs in connection with the construction of weep holes, including the gravel backfill for drains surrounding the weep holes except as provided in Section 2-09.4, shall be included by the Contractor in the unit contract price per cubic meter for "Conc. Class ____".

"Lean Concrete", per cubic meter.

Lean concrete, except when included in another bid item, will be paid for at the unit contract price per cubic meter.

"St. Reinf. Bar", per kilogram.

"Epoxy-Coated St. Reinf. Bar", per kilogram.

Payment for reinforcing steel shall include the cost of furnishing, fabricating, and placing the reinforcement. In structures of reinforced concrete where there are no structural steel bid items, such minor metal parts as expansion joints, bearing assemblies, and bolts will be paid for at the unit contract price for "Reinforcing Bar" unless otherwise specified.

"Gravel Backfill for Foundation Class A", per cubic meter.

"Gravel Backfill for Foundation Class B", per cubic meter.

"Gravel Backfill for Wall", per cubic meter.

"Deficient Strength Conc. Price Adjustment", by calculation.

"Deficient Strength Conc. Price Adjustment" will be calculated and paid for as described in Section 6-02.3(5)L. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount for the item "Deficient Strength Conc. Price Adjustment" in the bid proposal to become a part of the total bid by the Contractor. The item "Deficient Strength Conc. Price Adjustment" covers all applicable classes of concrete.

6-03 STEEL STRUCTURES

6-03.1 Description

This work includes furnishing, fabricating, erecting, cleaning, and painting steel structures and the structural steel parts of nonsteel structures.

6-03.2 Materials

Materials shall meet the requirements of the following sections:

Structural Steel and Related Materials	9-06
Paints	9-08

Structural steel shall be classified as:

1. Structural carbon steel (to be used whenever the Plans do not specify another classification),
2. Structural low alloy steel, and
3. Structural high strength steel.

Unless the Plans or Special Provisions state otherwise, the following shall be classified as structural carbon steel: shims; ladders; stairways; anchor bolts and sleeves; pipe, fittings and fastenings used in handrails; and other metal parts, even if made of other materials, for which payment is not specified.

All AASHTO M 270M material used in what the Plans show as main load-carrying tension members or as tension components of flexural members shall meet the Charpy V-notch requirements of AASHTO M 270M temperature zone 2.

All AASHTO M 270M material used in what the Plans show as fracture critical members shall meet the Charpy V-notch requirements of AASHTO M 270M, Fracture Critical Impact Test requirements, temperature zone 2. Charpy V-notch requirements for other steel materials shall be as specified in the Plans and Special Provisions.

The Contractor shall submit for the Engineer's approval a written plan for visibly marking the material so that it can be traced. These marks shall remain visible at least through the fit-up of the main load-carrying tension members. The marking method shall permit the Engineer to verify: (1) material specification designation, (2) heat number, and (3) material test reports to meet any special requirements.

For steel in main load-carrying tension members and in tension components of flexural members, the Contractor shall include the heat numbers on the reproducible copies of the as-built shop plans.

6-03.3 Construction Requirements

Structural steel fabricators of girders, floorbeams, truss members, and stringers, for permanent steel bridges, shall be certified under the AISC Quality Certification Program, Major Steel Bridges Category. When fracture critical members are specified in the contract, structural steel fabricators shall also have an endorsement F, Fracture Critical, under the AISC Quality Certification Program.

6-03.3(1) Notice of Rolling

Before rolling work begins, the Contractor shall provide enough notice that the Engineer may arrange to inspect it. The Contractor shall inform the Engineer of who will do the work and where it will be done. No material shall be rolled until the Engineer gives written notice to proceed.

6-03.3(2) Facilities for Inspection

The Contractor shall provide all facilities the Inspector requires to inspect material and workmanship. Inspectors shall be given safe and free access to all areas in the mill and shop.

6-03.3(3) Inspector's Authority

The Inspector may reject materials or workmanship that does not comply with these Specifications. In any dispute, the Contractor may appeal to the Engineer whose decision shall be final.

By its inspection at the mill and shop, the Contracting Agency intends only to facilitate the work and prevent errors. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material or workmanship.

6-03.3(4) Rejections

Even if the Inspector accepts materials or finished members, the Contracting Agency may later reject them if defective. The Contractor shall promptly replace or make good any rejected materials or workmanship.

6-03.3(5) Mill Orders and Shipping Statements

The Contractor shall furnish as many copies of mill orders and shipping statements as the Engineer requires.

6-03.3(6) Weighing

Structural steel need not be weighed unless the Plans or Special Provisions require it. When a mass is required, it may either be calculated or obtained by scales. The Contractor shall furnish as many copies of the calculations or mass slips as the Engineer requires. If scale masses are used, the Contractor shall record separately the masses of all tools, erection material, and dunnage.

6-03.3(7) Shop Plans

The Contractor shall submit for approval all shop detail plans for fabricating the steel. These shall be sent to the Bridge and Structures Engineer, Department of Transportation, Transportation Building, Olympia, WA 98504. If these plans will be submitted directly from the fabricator, the Contractor shall so notify the Project Engineer in writing.

Prints of the plans shall be supplied in these quantities:

1. Eight sets to the Bridge and Structures Engineer (four more sets are required for each affected railroad company on any grade separation structure that carries a railroad over a highway), and
2. Two sets to the Project Engineer.

The Bridge and Structures Engineer will return the Plans to the Project Engineer, who will forward copies to the Contractor. If any sheets require correction, the Contractor shall correct and resubmit them in the quantities required above. No material shall be fabricated until: (1) the Bridge and Structures Engineer has approved the plans, and (2) the FOSSC Materials Engineer has approved the materials source and the fabricator.

In approving shop plans, the Contracting Agency accepts only the nature and scope of the details without validating any dimensions.

Unless the Engineer permits it in writing, no changes shall be made in any drawing after its approval.

Before physical completion of the project, the Contractor shall furnish the Project Engineer one set of reproducible copies of the as-built shop plans. (One more set is required for each affected railroad company on any grade separation structure that carries a railroad over a highway.) The reproducible copies shall be clear, suitable for microfilming, and on permanent sheets that measure 560 mm by 865 mm.

6-03.3(7)A Erection Methods

Before beginning to erect any steel structure, the Contractor shall submit to the Engineer for review and shall have received approval for the erection plan and procedure describing the methods the Contractor intends to use. The Contractor's erection plan and procedure shall be reviewed by the steel fabricator prior to being submitted to the Engineer. The Contractor shall submit evidence that the fabricator has reviewed the erection plans and procedure; and submit the fabricator's review comments to the Engineer along with the erection plan submittal.

The erection plan and procedure shall provide complete details of the erection process including but not limited to:

1. Temporary falsework support, bracing, guys, deadmen, and attachments to other structure components or objects;
2. Procedure and sequence of operation;
3. Girder stresses during progressive stages of erection;
4. Girder masses , lift points, and lifting devices, spreaders, glommers, etc.;
5. Crane(s) make and model, mass, geometry, lift capacity, outrigger size and reactions;
6. Girder launcher or trolley details and capacity (if intended for use); and
7. Locations of cranes, barges, trucks delivering girders, and the location of cranes and outriggers relative to other structures, including retaining walls and wing walls.

The erection plan shall include drawings, notes, catalog cuts, and calculations clearly showing the above listed details, assumptions, and dimensions. Material properties, specifications, structural analysis, and any other data used shall also be included. The plan shall be prepared by (or under the direct supervision of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural, and shall carry the engineer's seal and signature, in accordance with Section 6-02.3(16).

The Contractor shall submit the erection plans, calculations, procedure, and fabricator's comments directly to the Bridge and Structures Office, Construction Support Engineer, in accordance with Section 6-02.3(16). After the plan is approved and returned to the Contractor, all changes that the Contractor proposes shall be submitted to the Project Engineer for review and approval.

6-03.3(8) Substitutions

The Contractor shall not substitute sections that differ from plan dimensions unless the Engineer approves in writing. If the Contractor requests and receives approval to substitute heavier members, the Contracting Agency shall not pay any added cost.

In lieu of the metric plate sizes specified, the Contractor may substitute English plate sizes, subject to the following conditions:

1. The English steel plates shall conform to the English AASHTO or ASTM material specification equivalent to the specified metric material specification.

2. The Contractor shall identify the material substitution on all shop plans submitted to the Engineer for approval, and on all Manufacturer's Certificate of Compliance submitted to the Engineer.
3. The Contractor shall be responsible for all plan dimension and geometry revisions required as a result of the substitution.
4. The Contractor shall make the substitution at no additional cost to the Contracting Agency.
5. The substitutions shall conform to the following table:

Metric Plate Thickness in Plans (mm)	Equivalent English Plate Thickness (inches)
5	3/16
6	1/4
8	5/16
10	3/8
11	7/16
12	1/2
14	9/16
16	5/8
18	11/16
20	3/4
22	7/8
25	1
30	1 1/8
32	1 1/4
35	1 3/8
38	1 1/2
40	1 5/8
45	1 3/4
50	2
55	2 1/4
60	2 3/8
70	2 3/4
80	3 1/4
100	4

6-03.3(9) Handling, Storing, and Shipping of Materials

Markings applied at the mill shall distinguish structural low alloy steel from structural carbon steel. The fabricator shall keep the two classes of steel carefully separated.

Before fabrication, all material stored at the fabricating plant shall be protected from rust, dirt, oil, and other foreign matter. The Contracting Agency will accept no rust-pitted material.

After fabrication, all material awaiting shipment shall be subject to the same storage requirements as unfabricated material.

All structural steel shall arrive at the job in good condition. As the Engineer requires, steel damaged by salt water shipment shall be thoroughly cleaned by high pressure water flushing, chemical cleaning, or sandblasting, and repainted with the specified shop coat.

All material shall be stored so as to prevent rust and loss of small parts. Piled material shall not rest on the ground or in water but on skids or platforms.

The loading, transporting, unloading, and piling of the structural steel material shall be so conducted that the metal will be kept clean and free from injury from rough handling.

In field assembly of structural parts, the Contractor shall use methods and equipment not likely to twist, bend, deform, or otherwise injure the metal. Any member slightly bent or twisted shall be corrected before it is placed. The Contracting Agency will reject any member with serious handling damage.

Girder sections shall be handled so as to prevent damage to the girders. If necessary, the Contractor shall provide temporary stiffeners to prevent buckling during erection.

6-03.3(10) Straightening Bent Material

If the Engineer permits in writing, plates, angles, other shapes, and built-up members may be straightened. Straightening methods shall not fracture or injure the metal. Distorted members shall be straightened mechanically. A limited amount of localized heat may be applied only if carefully planned and supervised, and only if the Engineer has approved a heat-straightening procedure in writing.

Parts to be heat-straightened shall be nearly free from all stress and external forces except those that result from the mechanical pressure used with the heat.

After straightening, the Contractor will inspect the member for fractures using a method determined by the Contracting Agency.

The Contracting Agency will reject metal showing sharp kinks and bends.

The procedure for heat straightening of universal mill (UM) plates by the mill or the fabricator shall be submitted to the Engineer for approval.

6-03.3(11) Workmanship and Finish

Workmanship and finish shall be first-class, equaling the best practice in modern bridge fabrication shops. Welding, shearing, burning, chipping, and grinding shall be done neatly and accurately. All parts of the work exposed to view shall be neatly finished.

Wherever the Plans show a surface finish symbol, the surface shall be machined.

6-03.3(12) Falsework

All falsework shall meet the requirements of Section 6-02.

6-03.3(13) Fabricating Tension Members

Plates for main load-carrying tension members or tension components of flexural members shall be:

1. Blast cleaned entirely or blast cleaned on all areas within 50 millimeters of welds to SSPC-SP6, Commercial Blast Cleaning, and
2. Fabricated from plate stock with the primary rolling direction of the stock parallel to the length of the member.

6-03.3(14) Edge Finishing

All rolled, sheared, and flame-cut edges shall be true to line and free of rough corners and projections. Corners along exposed edges shall be rounded to a minimum radius of 2 millimeters.

Sheared edges on plates more than 16 millimeters thick shall be planed, milled, ground, or flame-cut to a depth of at least 3 millimeters.

Re-entrant corners or cuts shall be filleted to a minimum radius of 19 millimeters.

Exposed edges of main load-carrying tension members or tension components of flexural members shall have a surface roughness no greater than 6.35 micrometers as defined by the American National Standards Institute, ANSI B46.1, Surface Texture. Exposed edges of other members shall have surface roughness no greater than 25.4 micrometers.

The hardness of flame-cut edges of structural low alloy steel plates, as specified in Section 9-06.2, for main load-carrying tension members or tension components of flexural members shall meet the requirements outlined in Appendix A, "Testing Rockwell Hardness of Flame-cut Edges" of the Contract Provisions. The Contractor shall prevent excessive hardening of plate edges through preheating, postheating, or control of the burning process as recommended by the steel manufacturer and approved by the Engineer.

6-03.3(15) Planing of Bearing Surfaces

Ends of columns that bear on base and cap plates shall be milled to true surfaces and accurate bevels.

When assembled, caps and base plates of columns and the sole plates of girders and trusses shall have full contact. If warped or deformed, the plates shall be heat straightened, planed, or corrected in some other way to produce accurate, even contact. If necessary for proper contact, bearing surfaces that will contact other metal surfaces shall be planed or milled. Surfaces of warped or deformed base and sole plates that will contact masonry shall be rough finished.

On the surface of expansion bearings, the cut of the planer shall be in the direction of expansion.

6-03.3(16) Abutting Joints

Abutting ends of compression members shall be faced accurately so that they bear evenly when in the structure. On built-up members, the ends shall be faced or milled after fabrication.

Ends of tension members at splices shall be rough finished to produce neat, close joints. A contact fit is not required.

6-03.3(17) End Connection Angles

On floorbeams and stringers, end connection angles shall be flush with each other and set accurately in relationship to the position and length of the member. Unless the Plans require it, end connection angles shall not be finished. If, however, faulty assembly requires them to be milled, milling shall not reduce thickness by more than 1.6 millimeters.

6-03.3(18) Built Members

The various pieces forming one built member shall be straight and close-fitting, true to detailed dimensions, and free from twists, bends, open joints, or other defects.

When fabricating curved girders, localized heat or the use of mechanical force shall not be used to bend the girder flanges about an axis parallel to girder webs.

6-03.3(19) Hand Holes

Hand holes, whether punched or cut with burning torches, shall be true to sizes and shapes shown in the Plans. Edges shall be true to line and ground smooth.

6-03.3(20) Lacing Bars

Unless the Plans state otherwise, ends of lacing bars shall be neatly rounded.

6-03.3(21) Plate Girders

6-03.3(21)A Web Plates

If web plates are spliced, clearance between plate ends shall not exceed 10 millimeters.

6-03.3(21)B Vacant

6-03.3(21)C Web Splices and Fillers

Web splice plates and fillers under stiffeners shall fit within 3 millimeters at each end. In lieu of the steel material specified in the Plans or Special Provisions, the Contractor may substitute ASTM A 715 steel for all filler plates less than 6 millimeters thickness.

6-03.3(22) Eyebars

Eyebars shall be straight, true to size, and free from twists or folds in the neck or head and from any other defect that would reduce their strength. Heads shall be formed by upsetting, rolling, or forging. Dies in use by the manufacturer may determine the shape of bar heads if the Engineer approves. Head and neck thickness shall not overrun by more than 1.6 millimeters. Welds shall not be made in the body or head of any bar.

Each eyebar shall be properly annealed and carefully straightened before it is bored. Pinholes shall be located on the centerline of each bar and in the center of its head. Holes in bar ends shall be so precisely located that in a pile of bars for the same truss panel the pins may be inserted completely without driving. All eyebars made for the same locations in trusses shall be interchangeable.

6-03.3(23) Annealing

All eyebars shall be annealed by being heated uniformly to the proper temperature, then cooled slowly and evenly in the furnace. At all stages, the temperature of the bars shall be under full control.

Slight bends on secondary steel members may be made without heat. Crimped web stiffeners need no annealing.

6-03.3(24) Pins and Rollers

Pins and rollers shall be made of the class of forged steel the Plans specify. They shall be turned accurately to detailed dimensions, smooth, straight, and flawless. The final surface shall be produced by a finishing cut.

Pins and rollers 230 millimeters or less in diameter may either be forged and annealed or made of cold-finished carbon steel shafting.

Pins more than 230 millimeters in diameter shall have holes at least 50 millimeters in diameter bored longitudinally through their centers. Pins with inner defects will be rejected.

The Contractor shall provide pilot and driving nuts for each size of pin unless the Plans state otherwise.

6-03.3(24)A Boring Pin Holes

Pin holes shall be bored true to detailed dimensions, smooth and straight, and at right angles to the axis of the member. Holes shall be parallel with each other unless the Plans state otherwise. A finishing cut shall always be made.

The distance between holes shall not vary from detailed dimensions by more than 0.8 millimeter. In tension members, this distance shall be measured from outside to outside of holes; in compression members, inside to inside.

6-03.3(24)B Pin Clearances

Each pin shall be 0.5 millimeter smaller in diameter than its hole. All pins shall be numbered after being fitted into their holes in the assembled member.

6-03.3(25) Welding and Repair Welding

Welding and repair welding of all steel bridges shall comply with the ANSI/AASHTO/AWS D1.5-96 Bridge Welding Code. Welding and repair welding for all other steel fabrication shall comply with the AWS D1.1, latest edition, Structural Welding Code. The requirements described in the remainder of this section shall prevail whenever they differ from either of the above welding codes.

The Contractor shall weld structural steel only to the extent shown in the Plans. No welding, including tack and temporary welds shall be done in the shop or field unless the location of the welds is shown on the approved shop drawings or approved by the Engineer in writing.

Welding procedures shall be submitted for approval with shop drawings. The procedures shall specify the type of equipment to be used, electrode selection, preheat requirements, base materials, and joint details. When the procedures are not prequalified by AWS or AASHTO, evidence of qualification tests shall be submitted.

Welding shall not begin until after the Contractor has received the Engineer's approval of shop plans as required in Section 6-03.3(7). These plans shall include procedures for welding, assembly, and any heat-straightening or heat-curving.

Any welded shear connector longer than 200 millimeters may be made of two shorter shear connectors joined with full-penetration welds.

In shielded metal-arc welding, the Contractor shall use low-hydrogen electrodes.

In submerged-arc welding, flux shall be oven-dried at 290°C for at least 2 hours, then stored in ovens held at 120°C or more. If not used within 4 hours after removal from a drying or storage oven, flux shall be redried before use.

Preheat and interpass temperatures shall conform to the applicable welding code as specified in this section. When welding main members of steel bridges, the minimum preheat shall not be less than 38°C.

If groove welds (web-to-web or flange-to-flange) have been rejected, they may be repaired no more than twice. If a third failure occurs, the Contractor shall:

1. Trim the members, if the Engineer approves, at least 12 millimeters on each side of the weld; or
2. Replace the members at no expense to the Contracting Agency.

By using extension bars and runoff plates, the Contractor shall terminate groove welds in a way that ensures the soundness of each weld to its ends. The bars and plates shall be removed after the weld is finished and cooled. The weld ends shall then be ground smooth and flush with the edges of abutting parts.

The Contractor shall not:

1. Weld with electrogas or electroslag methods,
2. Weld nor flame cut when the ambient temperature is below –7°C, or
3. Use coped holes in the web for welding butt splices in the flanges unless the Plans show them.

6-03.3(25)A Welding Inspection

The Contractor's inspection procedures, techniques, methods, acceptance criteria, and inspector qualifications for welding of steel bridges shall be in accordance with the ANSI/AASHTO/AWS D1.5-96 Bridge Welding Code. The Contractor's inspection procedures, techniques, methods, acceptance criteria, and inspector qualifications for welding of steel structures other than steel bridges shall be in accordance with AWS D1.1, latest edition, Structural Welding Code. The requirements described in the remainder of this section shall prevail whenever they differ from either of the above welding codes.

Nondestructive testing in addition to visual inspection shall be performed by the Contractor. Unless otherwise shown in the Plans or specified in the Special Provisions, the extent of inspection shall be as specified in this section. Testing and inspection shall apply to welding performed in the shop and in the field.

Visual Inspection

All welds shall be 100 percent visually inspected. Visual inspection shall be performed before, during, and after the completion of welding.

Radiographic Inspection

Complete penetration tension groove welds in highway bridges shall be 100 percent radiographically inspected. These welds include those in the tension area of webs, where inspection shall cover the greater of these two distances: (a) 380 millimeters from the tension flange, or (b) one third of the web depth. In addition, edge blocks conforming to the requirements of AWS D1.1-96 Structural Welding Code Section 6.17.13 shall used for radiographic inspection.

Ultrasonic Inspection

Complete penetration groove welds on plates thicker than 8 millimeters in the following welded assemblies or structures shall be 100 percent ultrasonically inspected:

1. Welded connections and splices in highway bridges and earth retaining structures, excluding longitudinal butt joint welds in beam or girder webs.
2. Bridge bearings and modular expansion joints.
3. Sign bridges, cantilever sign structures, and bridge mounted sign brackets excluding longitudinal butt joint welds in beams.
4. Light, signal, and strain pole standards.

The testing procedure and acceptance criteria for tubular members shall conform to the requirements of the AWS D1.1 latest edition, Structural Welding Code.

Magnetic Particle Inspection

1. Fillet and partial penetration groove welds:

   At least 30 percent of each size and type of fillet welds (excluding intermittent fillet welds) and partial penetration groove welds in the following welded assemblies or structures shall be tested by the magnetic particle method:

   a. Flange-to-web connections in highway bridges.
   b. End and intermediate pier diaphragms in highway bridges.
   c. Stiffeners and connection plates in highway bridges.
   d. Welded connections and splices in earth retaining structures.

e. Boxed members of trusses.
f. Bridge bearings and modular expansion joints.
g. Sign bridges, cantilever sign structures, and bridge mounted sign brackets.
h. Light, signal, and strain pole standards.

2. Longitudinal butt joint welds in beam and girder webs:
   At least 30 percent of each longitudinal butt joint weld in the beam and girder webs shall be tested by the magnetic particle method.
3. Complete penetration groove welds on plates 8 millimeters or thinner shall be 100 percent tested by the magnetic particle method. Testing shall apply to both sides of the weld, if backing plate is not used.
4. The ends of each complete penetration groove weld at plate edges shall be tested by the magnetic particle method.

Where 100 percent testing is not required, the Engineer reserves the right to select the location(s) for testing.

If rejectable flaws are found in any test length of weld in Item 1 or 2 above, the full length of the weld or 1.5 meters on each side of the test length, whichever is less, shall be tested.

After the Contractor's welding inspection is complete, the Contractor shall allow the Engineer sufficient time to perform quality assurance ultrasonic welding inspection.

The Contractor shall maintain the radiographs and the radiographic inspection report in the shop until the last joint to be radiographed in that member is accepted by the radiographer representing the Contractor. Within two working days following this acceptance, the Contractor shall mail the film and two copies of the radiographic inspection report to the Materials Engineer, Department of Transportation, PO Box 167, Olympia, WA 98504.

6-03.3(26) Screw Threads

Screw threads shall be metric and shall fit closely in the nuts.

6-03.3(27) High Strength Bolt Holes

At the Contractor's option under the conditions described in this section, holes may be punched or subpunched and reamed, drilled or subdrilled and reamed, or formed by numerically controlled drilling operations.

The hole for each high strength bolt shall be 2 millimeters larger than the nominal diameter of the bolt.

In fabricating any connection, the Contractor may subdrill or subpunch the holes then ream full size after assembly or drill holes full size from the solid with all thicknesses of material shop assembled in the proper position. If the Contractor chooses not to use either of these methods, then the following shall apply:

1. Drill bolt holes in steel splice plates full size using steel templates.
2. Drill bolt holes in the main members of trusses, arches, continuous beam spans, bents, towers, plate girders, box girders, and rigid frames at all connections as follows:
   a. A minimum of 30 percent of the holes in one side of the connection shall be made full size using steel templates.
   b. A minimum of 30 percent of the holes in the second side shall be made full size assembled in the shop.
   c. All remaining holes may be made full size in unassembled members using steel templates.

3. Drill bolt holes in crossframes, gussets, lateral braces, and other secondary members full size using steel templates.

The Contractor shall submit for the Engineer's approval a detailed outline of the procedures proposed to accomplish the work from initial drilling through shop assembly.

6-03.3(27)A Punched Holes

For punched holes, die diameter shall not exceed punch diameter by more than 1.5 millimeters. Any hole requiring enlargement to admit the bolt shall be reamed. All holes shall be cut clean with no torn or ragged edges. The Contracting Agency will reject components having poorly matched holes.

6-03.3(27)B Reamed and Drilled Holes

Reaming and drilling shall be done with short taper reamers or twist drills, producing cylindrical holes perpendicular to the member. Reamers and drills shall be directed mechanically, not hand-held. Connecting parts that require reamed or drilled holes shall be assembled and held securely as the holes are formed, then match-marked before disassembly. The Contractor shall provide the Engineer a diagram showing these match-marks. The Contracting Agency will reject components having poorly matched holes.

Burrs on outside surfaces shall be removed. If the Engineer requires, the Contractor shall disassemble parts to remove burrs.

If templates are used to ream or drill full-size connection holes, the templates shall be positioned and angled with extreme care and bolted firmly in place. Templates for reaming or drilling matching members or the opposite faces of one member shall be duplicates. All splice components shall be match-marked unless otherwise approved by the Engineer.

6-03.3(27)C Numerically Controlled Drilled Connections

In forming any hole described in Section 6-03.3(27), the fabricator may use numerically controlled (N/C) drilling or punching equipment if it meets the requirements in this subsection.

The Contractor shall submit for approval a detailed outline of proposed N/C procedures. This outline shall:

1. Cover all steps from initial drilling or punching through check assembly;
2. Include the specific members of the structure to be drilled or punched, hole sizes, locations of the common index and other reference points, makeup of check assemblies, and all other information needed to describe the process fully.

N/C holes may be drilled or punched to size through individual pieces, or may be drilled through any combination of tightly clamped pieces.

When the Engineer requires, the Contractor shall demonstrate that the N/C procedure consistently produces holes and connections meeting the requirements of these Specifications.

6-03.3(27)D Accuracy of Punched, Subpunched, and Subdrilled Holes

After shop assembly and before reaming, all punched, subpunched, and subdrilled holes shall meet the following standard of accuracy. At least 75 percent of the holes in each connection shall permit the passage of a cylindrical pin 3 millimeters smaller in diameter than nominal hole size. This pin shall pass through at right angles to the face of the member without drifting. All holes shall permit passage of a pin 5 millimeters smaller in diameter than nominal hole size. The Contracting Agency will reject any pieces that fail to meet these standards.

6-03.3(27)E Accuracy of Reamed and Drilled Holes

At least 85 percent of all holes in a connection of reamed or drilled holes shall show no offset greater than 1 millimeters between adjacent thicknesses of metal. No hole shall have an offset greater than 2 millimeters.

Centerlines from the connection shall be inscribed on the template and holes shall be located from these centerlines. Centerlines shall also be used for accurately locating the template relative to the milled or scribed ends of the members.

Templates shall have hardened steel bushing inserted into each hole. These bushings may be omitted, however, if the fabricator satisfies the Engineer (1) that the template will be used no more than 5 times, and (2) that use will produce no template wear.

Each template shall be at least 12 millimeters thick. If necessary, thicker templates shall be used to prevent buckling and misalignment as holes are formed.

6-03.3(27)F Fitting for Bolting

Before drilling, reaming, and bolting begins, all parts of a member shall be assembled, well pinned, and drawn firmly together. If necessary, assembled pieces shall be taken apart to permit removal of any burrs or shavings produced as the holes are formed. The member shall be free from twists, bends, and other deformation.

In shop-bolted connections, contacting metal surfaces shall be sandblasted clean before assembly. Sandblasting shall meet the requirements of the SSPC Specifications for Commercial Blast Cleaning (SSPC-SP 6).

Any drifting done during assembly shall be no more than enough to bring the parts into place. Drifting shall not enlarge the holes or distort the metal.

6-03.3(28) Shop Assembly

6-03.3(28)A Method of Shop Assembly

Unless the contract states otherwise, the Contractor shall choose one of the five shop assembly methods described below that will best fit the proposed erection method. The Contractor shall obtain the Engineer's approval of both the shop assembly and the erection methods before work begins.

1. Full Truss or Girder Assembly: Each truss or girder is completely assembled over the full length of the superstructure.
2. Progressive Truss or Girder Assembly: Each truss or girder is assembled in stages longitudinally over the full length of the superstructure.
   a. For trusses: The first stage shall include at least three adjacent truss panels. Each truss panel shall include all of the truss members in the space bounded by the top and bottom chords and the horizontal distance between adjacent bottom chord Joints.
   b. For girders: The first stage shall include at least three adjacent girder shop sections. Shop sections are measured from the end of the girder to the first field splice or from field splice to field splice.
   c. For trusses and girders: After the first stage has been completed, each subsequent stage shall be assembled to include: two truss panels or girder shop sections of the previous stage and one or more truss panels or girder shop sections added at the advancing end. The previous stages shall be repositioned if necessary, and pinned to ensure accurate alignment. For

straight sections of bridges without skews or tapers, girders in each subsequent stage may be assembled to include one girder shop section from the previous stage and one or more girder shop sections at the advancing end.

If the bridge is longer than 45 meters, each longitudinal stage shall be at least 45 meters long, regardless of the length of individual continuous truss panels or girder shop sections.

The Contractor may begin the assembly sequence at any point on the bridge and proceed in either or both directions from that point.

Unless the Engineer approves otherwise, no assembly shall have less than three truss panels or girder shop sections.

3. Full Chord Assembly: The full length of each chord for each truss is assembled with geometric angles at the joints. Chord connection bolt holes are drilled/reamed while members are assembled. The truss web member connections are drilled/reamed to steel templates set by relating geometric angles to the chord lines.

   At least one end of each web member shall be milled or scribed at right angles to its long axis. The templates at both ends of the member shall be positioned accurately from the milled end or scribed line.
4. Progressive Chord Assembly: Adjacent chord sections are assembled in the same way as specified for Full Chord Assembly, using the procedure specified for Progressive Truss or Girder Assembly.
5. Special Complete Structure Assembly: All structural steel members (superstructure and substructure, including all secondary members) are assembled at one time.

6-03.3(28)B Check of Shop Assembly

The Contractor shall check each assembly for alignment, accuracy of holes, fit of milled joints, and other assembly techniques. Drilling or reaming shall not begin until the Engineer has given approval. If the Contractor uses N/C drilling, this approval must be obtained before the assembly or stage is dismantled.

6-03.3(29) Vacant

6-03.3(30) Painting

All painting shall be in accordance with Section 6-07.

6-03.3(30)A Vacant

6-03.3(30)B Vacant

6-03.3(30)C Erection Marks

Erection marks to permit identification of members in the field shall be painted on previously painted surfaces.

6-03.3(30)D Machine Finished Surfaces

As soon as possible and before they leave the shop, machine-finished surfaces on abutting chord splices, column splices, and column bases shall be covered with grease. After erection, the steel shall be cleaned and painted as specified.

All surfaces of iron and steel castings milled to smooth the surface shall be painted with the primer called for in the specified paint system.

While still in the shop, machine-finished surfaces and inaccessible surfaces of rocker or pin-type bearings shall receive the full paint system. Surfaces of pins and holes machine-finished to specific tolerances shall not be painted. But as soon as possible and before they leave the shop, they shall be coated with grease.

6-03.3(31) Alignment and Camber

Before beginning field bolting, the Contractor shall:

1. Adjust the structure to correct grade and alignment,
2. Regulate elevations of panel points (ends of floorbeams), and
3. Delay bolting at compression joints until adjusting the blocking to provide full and even bearing over the whole joint.

On truss spans, a slight excess camber will be permitted as the bottom chords are bolted. But camber and relative elevations of panel points shall be correct before the top chord joints, top lateral system, and sway braces are bolted.

6-03.3(31)A Measuring Camber

The Contractor shall provide the Engineer with a diagram for each truss that shows camber at each panel point. This diagram shall display actual measurements taken as the truss is being assembled.

6-03.3(32) Assembling and Bolting

To begin bolting any field connection or splice, the Contractor shall install and tighten to snug-tight enough bolts to bring all parts into full contact with each other prior to tightening these bolts to the specified minimum tension. “Snug-tight” means either the tightness reached by (l) a few blows from an impact wrench or (2) the full effort of a person using a spud wrench.

As erection proceeds, all field connections and splices for each member shall be securely drift pinned and bolted in accordance with 1 or 2 below before the mass of the member can be released or the next member is added. Field erection drawings shall specify pinning and bolting requirements that meet or exceed the following minimums:

1. Joints in normal structures. Fifty percent of the holes in a single field connection and fifty percent of the holes on each side of a single joint in a splice plate shall be filled with drift pins and bolts. Thirty percent of the filled holes shall be pinned. Seventy percent of the filled holes shall be bolted and tightened to snug-tight. Once all these bolts are snug-tight, each bolt shall be systematically tightened to the specified minimum tension. “Systematically tightened” means beginning with bolts in the most rigid part, which is usually the center of the joint, and working out to its free edges. The fully tensioned bolts shall be located near the middle of a single field connection or a single splice plate.
2. Joints in cantilevered structures. Seventy-five percent of the holes in a single field connection and 75 percent of the holes on each side of a single joint in a splice plate shall be filled with drift pins and bolts. Fifty percent of the filled holes shall be pinned. Fifty percent of the filled holes shall be bolted and tightened to snug-tight. Once all these bolts are snug-tight, each bolt shall be systematically tightened to the specified minimum tension. The fully tensioned bolts shall be located near the middle of a single field connection or a single splice plate.

Drift pins shall be placed throughout each field connection and each field joint with the greatest concentration in the outer edges of a splice plate or member being bolted.

To complete a joint following the method listed above, the Contractor shall fill all remaining holes of the field connection or splice plate with bolts and tighten to snug-tight. Once all of these bolts are snug-tight, each bolt shall be systematically tightened to the specified minimum tension. After these bolts are tightened to the specified minimum tension, the Contractor shall replace the drift pins with bolts tightened to the specified minimum tension.

The Contractor may complete a field bolted connection or splice in a continuous operation before releasing the mass of the member or adding the next member. The Contractor shall utilize drift pins to align the connection. The alignment drift pins shall fill between 15 and 30 percent of the holes in a single field connection and between 15 and 30 percent of the holes on each side of a single joint in a splice plate. Once the alignment drift pins are in place, all remaining holes shall be filled with bolts and tightened to snug-tight starting from near the middle and proceeding toward the outer gage lines. Once all of these bolts are snug-tight, the Contractor shall systematically tighten all these bolts to the specified minimum tension. The Contractor shall then replace the drift pins with bolts. Each of these bolts shall be tightened to the specified minimum tension.

All bolts shall be placed with heads toward the outside and underside of the bridge. All high-strength bolts shall be installed and tightened before the falsework is removed.

The Contractor may erect metal railings as erection proceeds. But railings shall not be bolted or adjusted permanently until the falsework is released and the deck placed.

The Contractor shall not begin painting until the Engineer has inspected and accepted field bolting.

6-03.3(33) Bolted Connections

Bolts, nuts, hardened washers, and direct tension indicators shall meet the requirements of Section 9-06.5(3).

All bolted connections are friction type. Painted structures require Type 1 or Type 2 bolts. Unpainted structures require Type 3 bolts. AASHTO M 253M Type 1, 2, and 3 bolts shall not be galvanized or be used in contact with galvanized material.

Hardened washers are required under turned elements for connections using AASHTO M 164M and AASHTO M 253M bolts and, as required in the following:

1. Irrespective of the tightening method, hardened washers shall be used under both the head and the nut when AASHTO M 253M bolts are to be installed in structural carbon steel, as specified in Section 9-06.1.
2. Where the outer face of the bolted parts has a slope greater than 1:20 with respect to a plane normal to the bolt axis, a hardened beveled washer shall be used to compensate for the lack of parallelism.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye so a visual check for the lubricant can be made at the time of field installation. Black bolts shall be “oily” to the touch when installed. Weathered or rusted bolts and nuts shall be cleaned and relubricated prior to installation.

After assembly, bolted parts shall fit solidly together. They shall not be separated by washers, gaskets, or any other material. Assembled joint surfaces, including those next to bolt heads, nuts, and washers, shall be free of loose mill scale, burrs, dirt, and other foreign material that would prevent solid seating.

When all bolts in a joint are tight, each bolt shall carry at least the proof load shown in Table 3 below:

Table 3
Minimum Bolt Tension

Bolt Size (mm)	AASHTO M 164M (kN)	AASHTO M 253M (kN)
16	94.2	114
20	147	179
22	182	221
24	212	257
27	275	334
30	337	408
36	490	595

Tightening may be done by either the turn-of-nut or the direct-tension indicator method. Preferably, the nut shall be turned tight while the bolt is prevented from rotating. However, if required because of bolt entering and/or wrench operational clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Following are descriptions of the turn-of-nut and direct-tension-indicator methods:

1. Turn-of-Nut Method
   Hardened steel washers shall be used under the turned elements. After a bolt in a connection or joint splice plate has been tightened to snug-tight and all specified bolting conditions satisfied, it shall be tightened to the specified minimum tension by rotating the amount specified in Table 4. Before final tightening, the Contractor shall match-mark with crayon or paint the outer face of each nut and the protruding part of the bolt. To ensure that this tightening method is followed, the Engineer will (1) observe as the Contractor installs and tightens all bolts and (2) inspect each match-mark.

Table 4
Turn-of-Nut Tightening Method
Nut Rotational from Snug-Tight Condition

Bolt Length	Disposition of Outer Faces of Bolted Parts		
	Condition 1	*Condition 2*	*Condition 3*
$L \leq 4D$	⅓ turn	½ turn	⅔ turn
$4D < L \leq 8D$	½ turn	⅔ turn	⅚ turn
$8D < L \leq 12D$	⅔ turn	⅚ turn	1 turn

Bolt length measured from underside of head to extreme end of point.

Condition 1 — both faces at right angles to bolt axis.

Condition 2 — one face at right angle to bolt axis, one face sloped no more than 1:20, without bevel washer.

Condition 3 — both faces sloped no more than 1:20 from right angle to bolt axis, without bevel washer.

Nut rotation is relative to the bolt regardless of which element (nut or bolt) is being turned. Tolerances permitted plus or minus 30 degrees (1/12 turn) for final turns of ½ turn or less; plus or minus 45 degrees (⅛ turn) for final turns of ⅔ turn or more.

D = nominal bolt diameter of bolt being tightened.

When bolt length exceeds 12D, the rotation shall be determined by actual tests in which a suitable tension device simulates actual conditions.

2. Direct-Tension-Indicator Method

DTIs shall not be used under the turned element. Direct-Tension-Indicators (DTIs) shall be placed under the bolt head with the protrusions facing the bolt head when the nut is turned. DTIs shall be placed under the nut with the protrusions facing the nut when the bolt is turned.

DTIs shall be installed by two or more person crews with one individual preventing the element at the DTI from turning the measuring the gap of the DTI to determine the proper tension of the bolt.

Three DTIs, per lot, shall be tested in a WSDOT approved bolt tension calibrator. The bolts shall be tensioned to 105 percent of the tension shown in Table 3. The test bolts shall not be tightened such that all of the DTI protrusions are completely crushed (all five openings with zero gap). The DTI gap between all protrusions shall be measured with a tapered feeler gage to the nearest 25.4 micrometer. All of the non-zero DTI gap measurements for the three test bolts shall be averaged. This average shall be used in the tightening of all the production bolts except as provided below.

All bolts in a connection shall be snug tightened prior to bringing any DTIs in the connection to full load. The maximum gap of the production bolt DTIs shall not be greater than the average test gap established above or 127 micrometers, whichever is less. The minimum gap of the production bolt DTIs may be zero (all five openings with zero gap).

The Contractor shall tension all bolts, inspecting all DTIs with a feeler gage, in the presence of the Engineer.

If a bolt, that has had its DTI brought to full load, loosens during the course of bolting the connection, the bolt shall have a new DTI installed and be retensioned. Reuse of the bolt and nut are subject to the provisions of this section.

AASHTO M 253M bolts and galvanized AASHTO M 164M bolts shall not be reused. Ungalvanized AASHTO M 164M bolts may be reused if approved by the Engineer. All bolts to be reused shall have their threads inspected for distortion by reinstalling the used nut on the bolt and turning the nut for the full length of the bolt threads by hand. Bolts to be reused shall be relubricated. Used bolts shall be subject to a rotational capacity test as specified in Section 6-03.3(33)A Pre-Erection Testing. Touching up or retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as reuse, provided the snugging up continues from the initial position and does not require greater rotation, including the tolerance, than that required by Table 4.

6-03.3(33)A Pre-Erection Testing

High strength bolt assemblies (bolt, nut, and washer), black and galvanized, shall be subjected to a rotational capacity test (AASHTO M 164M, Section 8.5) prior to any erection activity. Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly. All tests shall be performed by the Contractor in the presence of the Engineer. Two specimens per lot shall be tested at the erection site immediately prior to installation, or whenever the Engineer deems it necessary. The bolt assemblies shall meet the following requirements.

1. Go through two times the required number of turns from snug tight condition as indicated in Table 4 of Section 6-03.3(33) without stripping, tensile, or shear failure. Rotation-capacity test shall be performed in a WSDOT approved bolt tension calibrator.
2. The maximum recorded tension shall be equal to or greater than 1.15 times the minimum bolt tension listed in Table 3 of Section 6.03.3(33).
3. The measured torque to produce the minimum bolt tension shall not exceed the value obtained by the following equation.
   Torque = 0.25 PD
   Where: Torque = Calculated Torque (newton·meters)
   P = Measured Bolt Tension (newtons)
   D = Normal Bolt Diameter (meters)
4. Disassemble the torqued bolt and inspect for signs of failure. Failure is defined as any shear damage to the threads of the bolt or the nut or cracks in the body of the bolt. If either specimen fails, the lot of bolts will be rejected. Elongation of the bolt between the bolt head and the nut is not considered to be a failure.

6-03.3(33)B Bolting Inspection

The Contractor, in the presence of the Engineer, shall inspect the tightened bolt using an inspection torque wrench.

If the bolts to be installed are not long enough to fit in the Contracting Agency furnished tension calibrator, five bolts of the same grade, size, and condition as those under inspection shall be tested using Direct-Tension-Indicators (DTI) to measure bolt tension. This tension measurement test shall be done at least once each inspection day. The Contractor shall supply the necessary DTIs. The DTI shall be placed under the bolt head. A washer shall be placed under the nut, which shall be the element turned during the performance of this tension measurement test. Each bolt shall be tightened by any convenient means to the specified minimum tension as indicated by the DTI. The inspecting wrench shall then be applied to the tightened bolt to determine the torque required to turn the nut 5 degrees (approximately 25 millimeters at a 300-millimeter radius) in the tightening direction. The job inspection torque shall be taken as the average of three values thus determined after rejecting the high and low values.

Five bolts (provided by the Contractor) of the same grade, size, and condition as those under inspection shall be placed individually in a Contracting Agency furnished tension calibrator to measure bolt tension. This calibration operation shall be done at least once each inspection day. There shall be a washer under the part turned in tightening each bolt if washers are used on the structure. In the calibrated device, each bolt shall be tightened by any convenient means to the specified tension. The inspecting wrench shall then be applied to the tightened bolt to determine the torque required to turn the nut or head 5 degrees (approximately 25 millimeters at a 300-millimeter radius) in the tightening direction. The job-inspection torque shall be taken as the average of three values thus determined after rejecting the high and low values.

Ten percent (at least two) of the tightened bolts on the structure represented by the test bolts shall be selected at random in each connection. The job-inspection torque shall then be applied to each with the inspecting wrench turned in the tightening direction. If this torque turns no bolt head or nut, the Contracting Agency will accept the connection as being properly tightened. But if the torque turns one or more bolt heads or nuts, the job-inspection

torque shall then be applied to all bolts in the connection. Any bolt whose head or nut turns at this stage shall be tightened and reinspected. The Contractor may, however, retighten all the bolts in the connection and resubmit it for inspection.

6-03.3(34) Adjusting Pin Nuts

All pin nuts shall be tightened thoroughly. The pins shall be placed so that members bear fully and evenly on the nuts. The pins shall have enough thread to allow burring after the nuts are tightened.

6-03.3(35) Setting Anchor Bolts

Anchor bolts shall be set in masonry as required in Section 6-02.3(18). Anchor bolts shall be grouted in after the shoes, masonry plates, and keeper plates have been set and the span or series of continuous spans are completely erected and adjusted to line and camber.

6-03.3(36) Setting and Grouting Masonry Plates

The following procedure applies to masonry plates for all steel spans, including shoes, keeper plates, and turning racks on movable bridges.

To set masonry plates, the Contractor shall:

1. Set masonry plates on the anchor bolts;
2. Place steel shims under the masonry plates to position pin centers or bearings to line and grade and in relationship to each other. Steel shims shall be no more than 65 millimeters square and placed under plate webs;
3. Level the bases of all masonry plates;
4. Draw anchor bolt nuts down tight;
5. Recheck pin centers or bearings for alignment; and
6. Leave at least 20 millimeters of space under each masonry plate for grout.

After the masonry plates have been set and the span or series of continuous spans are completely erected and swung free, the space between the top of the masonry and the top of the concrete bearing seat shall be filled with grout. Main masonry plates for cantilever spans shall be set and grouted in before any steel work is erected.

Grout mixture and placement shall be as required in Section 6-02.3(20).

6-03.3(37) Setting Steel Bridge Bearings

Masonry plates, shoes, and keeper plates of expansion bearings shall be set and adjusted to center at a normal temperature of 18°C. Adjustment for an inaccuracy in fabricated length shall be made after dead-load camber is out.

6-03.3(38) Placing Superstructure

The Contractor shall place no superstructure load on finished piers or abutments until the Engineer allows. Normally, this concrete-hardening interval requires at least 12 days.

6-03.3(39) Swinging the Span

No forms, steel reinforcing bars, or concrete roadway slabs shall be placed on steel spans until the spans swing free on their supports and elevations recorded. No simple span or any series of continuous spans will be considered as swinging free until all temporary supports have been released. Forms, reinforcing steel, or concrete roadway slabs shall not be placed on any simple or continuous span steel girder bridge until all its spans are adjusted and its masonry plates, shoes, and keeper plates grouted. For this specification, the structure shall be considered as continuous across hinged joints.

After the falsework is released (spans swung free) the masonry plates, shoes, and keeper plates are grouted, and before any load is applied, the Engineer will:

1. Measure elevations at proper points along the tops of girders or floorbeams,
2. Compare steel mass camber elevations with the elevations measured in step 1, and
3. Furnish the Contractor with new dead-load camber dimension.

The Contractor shall adjust the top-of-web to top-of-deck dimensions, varying from Plan camber as necessary and as determined by the Engineer.

6-03.3(40) Draining Pockets

The Contractor shall provide enough holes to drain all water from pockets in trusses, girders, and other members. Unless shown on approved shop plans, drain holes shall not be drilled without the written approval of the Engineer.

All costs related to providing drain holes shall be included in the unit contract prices for structural or cast steel.

6-03.3(41) Floorbeam Protection

Each floorbeam that supports a concrete slab joint shall be coated on its top and flange edges with a heavy mop of roofing grade asphalt, applied hot. This asphalt shall conform to ASTM D 312 (not mineral stabilized). A protective covering of asphalt coated glass fiber sheet (ASTM D 4601 Type 1 non-perforated) shall be placed over the hot coat of asphalt. This combination coating shall be applied over the shop paint. It shall take the place of the two field coats of paint specified for other parts of the structural steel.

6-03.3(42) Surface Condition

As the structure is erected, the Contractor shall keep all steel surfaces clean and free from dirt, concrete, mortar, oil, paint, grease, and other stain-producing foreign matter. Any surfaces that become stained shall be cleaned as follows:

Painted steel surfaces shall be cleaned by methods required for the type of staining. The method shall be submitted to the Engineer for approval.

Unpainted steel surfaces shall be cleaned by sandblasting. Sandblasting to remove stains on publicly visible surfaces shall be done to the extent that, in the Engineers opinion, the uniform weathering characteristics of the structure are preserved.

6-03.3(43) Castings, Steel Forgings, and Miscellaneous Metals

Castings, steel forgings, and miscellaneous metals shall be built to comply with Section 9-06.

6-03.3(43)A Shop Construction, Castings, Steel Forgings, and Miscellaneous Metals

This section's requirements for structural steel (including painting requirements) shall also apply to castings, steel forgings, and miscellaneous metals.

Castings shall be:

1. True to pattern in form and dimensions;
2. Free from pouring faults, sponginess, cracks, blow holes, and other defects in places that would affect strength, appearance, or value;
3. Clean and uniform in appearance;
4. Filleted boldly at angles; and
5. Formed with sharp and perfect arises.

Iron and steel castings and forgings shall be annealed before any machining, unless the Plans state otherwise.

6-03.4 Measurement

Structural carbon steel, structural low alloy steel, and structural high strength steel will not be measured but will be paid for on a lump sum basis as described in Section 6-03.5.

Cast or forged metal (kind) or copper seals shown in the Plans will be measured by the kilogram or will be paid for on a lump sum basis, whichever is shown on the proposal.

6-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Structural Carbon Steel", lump sum.

The lump sum contract price for "Structural Carbon Steel" shall be full pay for all costs in connection with furnishing all materials, labor, tools, and equipment necessary for the manufacture, fabrication, transportation, erection, and painting of all structural carbon steel used in the completed structure, including the providing of such other protective coatings or treatment as may be shown in the Plans or specified in the Special Provisions.

For steel structures, the estimated mass of the structural carbon steel in the project will be shown in the Plans or in the Special Provisions. In the event any change in the Plans is made which will affect the mass of materials to be furnished, payment for the additional structural carbon steel required as a result of the change in the Plans will be made at a unit price per kilogram obtained by dividing the Contractor's lump sum bid for structural carbon steel by the total estimated mass of structural carbon steel shown in the Plans or in the Special Provisions.

Reductions in mass due to a change in the Plans will be made at the same rate as determined above and will be deducted from payments due the Contractor.

Prospective bidders shall verify the estimated mass of structural carbon steel before submitting a bid. No adjustment other than for approved changes will be made in the lump sum bid even though the actual mass may deviate from the stated estimated mass.

For concrete and timber structures, where the structural carbon steel is a minor item, no estimated mass will be given for the structural carbon steel. In the event any change in the Plans is necessary which will affect the mass of material to be furnished for this type of structure, the payment or reduction for the revision in quantity will be made at a unit price per kilogram obtained by dividing the Contractor's lump sum bid for the structural carbon steel by the calculated mass of the original material. The calculated mass will be established by the Engineer and will be based on an estimated mass of 7848.3 kilograms per cubic meter for steel.

Any change in the Plans which affects the mass of material to be furnished as provided herein will be subject to the provisions of Section 1-04.4.

"Structural Low Alloy Steel", lump sum.

"Structural High Strength Steel", lump sum.

Payment for "Structural Low Alloy Steel" and "Structural High Strength Steel" will be made on the same lump sum basis as specified for structural carbon steel.

"(Cast or Forged) Steel", lump sum or per kilogram.

"(Cast, Malleable, or Ductile) Iron", lump sum or per kilogram.

"Cast Bronze", lump sum or per kilogram.

Payment for “(Cast or Forged) Steel”, “(Cast, Malleable or Ductile) Iron”, and “Cast Bronze” will be made at the lump sum or per kilogram contract prices as included in the proposal.

For the purpose of payment, such minor items as bearing plates, pedestals, forged steel pins, anchor bolts, field bolts, shear connectors, etc., unless otherwise provided, shall be considered as structural carbon steel even though made of other materials.

When no bid item is included in the proposal and payment is not otherwise provided, the castings, forgings, miscellaneous metal, and painting shall be considered as incidental to the construction, and all costs therefore shall be included in the unit contract prices for the payment items involved and shown.

6-04 TIMBER STRUCTURES

6-04.1 Description

This work is the building of any structure or parts of structures (except piling) made of treated timber, untreated timber, or both. The Contractor shall erect timber structures on prepared foundations. The structures shall conform to the dimensions, lines, and grades required by the Plans, the Engineer, and these Specifications.

Any part of a timber structure made of nontimber materials shall comply with the sections of these Specifications that govern those materials.

6-04.2 Materials

Materials shall meet the requirements of the following sections:

Structural Steel and Related Material	9-06
Bolts, Washers, Other Hardware	9-06.22
Paints	9-08
Timber and Lumber	9-09

6-04.3 Construction Requirements

6-04.3(1) Storing and Handling Material

At the work site, the Contractor shall store all timber and lumber in piles. Weeds and rubbish under and around these piles shall have been removed before the lumber is stacked.

Untreated lumber shall be open stacked at least 300 millimeters above the ground. It shall be piled to shed water and prevent warping.

Treated timber shall be:

1. Cut, framed, and bored (whenever possible) before treatment;
2. Close stacked and piled to prevent warping;
3. Covered against the weather if the Engineer requires it;
4. Handled carefully to avoid sudden drops, broken outer fibers, and surface penetration or bruising with tools; and
5. Lifted and moved with rope or chain slings (without use of cant dogs, peaveys, hooks, or pike poles).

6-04.3(2) Workmanship

The Contractor shall employ only competent bridge carpenters. All their work shall be true and exact. Nails and spikes shall be driven with just enough force to leave heads flush with wood surfaces. The Contractor shall discharge any worker who displays poor workmanship by leaving deep hammer marks in wood surfaces. Workmanship on metal parts shall comply with requirements for steel structures.

6-04.3(3) Shop Details

The Contractor shall provide the Engineer with six sets of shop detail plans for all treated timber. These plans shall show dimensions for all cut, framed, or bored timbers. The Engineer will return to the Contractor one set of approved or corrected plans. No material shall be framed or bored until the Engineer approves the plans. Plans shall be drawn on sheets that conform to the sizes required in Section 1-05.3.

6-04.3(4) Field Treatment of Cut Surfaces, Bolt Holes, and Contact Surfaces

All cut surfaces, bolt holes, and contact surfaces shall be treated in accordance with Section 9-09.3 for all timber and lumber requiring preservative treatment.

All cuts and abrasions in treated piles or timbers shall be trimmed carefully and treated in accordance with Section 9-09.3.

6-04.3(5) Holes for Bolts, Dowels, Rods, and Lag Screws

Holes shall be bored:

1. For drift pins and dowels — with a bit 1 millimeter smaller in diameter than the pins and dowels.
2. For truss rods or bolts — with a bit the same diameter as the rods or bolts.
3. For lag screws — in two parts: (a) with the shank lead hole the same diameter as the shank and as deep as the unthreaded shank is long; and (b) with the lead hole for the threaded part approximately two thirds of the shank diameter.

6-04.3(6) Bolts, Washers, and Other Hardware

Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified in the Plans, but if not so specified shall be galvanized when used in treated timber structures.

Washers of the size and type specified shall be used under all bolt heads and nuts that would otherwise contact wood.

All bolts shall be checked by burring the threads after the nuts have been finally tightened. Vertical bolts shall have nuts on the lower ends.

Wherever bolts fasten timber to timber, to concrete, or to steel, the members shall be bolted tightly together at installation and retightened just before the Contracting Agency accepts the work. These bolts shall have surplus threading of at least 30 millimeters per meter of timber thickness to permit future tightening.

6-04.3(7) Countersinking

Countersinking shall be done wherever smooth faces are required. Each recess shall be treated in accordance with Section 9-09.3.

6-04.3(8) Framing

The Contractor shall cut and frame lumber and timber to produce close-fitting, full-contact joints. Each mortise shall be true to size for its full depth, and its tenon shall fit it snugly. Neither shimmed nor open joints are permitted.

6-04.3(9) Framed Bents

Mudsills shall be of pressure-treated timber, firmly and evenly bedded to solid bearing, and tamped in place.

Concrete pedestals that support framed bents shall be finished so that sills will bear evenly on them. To anchor the sills, the Contractor shall set dowels in the pedestals when they are cast. The dowels shall be at least 19 millimeters in diameter and protrude at least 150 millimeters above the pedestal tops. Pedestal concrete shall comply with Section 6-02.

Each sill shall rest squarely on mudsills, piles, or pedestals. It shall be drift-bolted to mudsills or piles with 19 millimeters diameter or larger bolts that extend at least 150 millimeters into them. When possible, the Contractor shall remove any earth touching the sills to permit free air circulation around them.

Each post shall be fastened to sills with 19-millimeter diameter or larger dowels that extend at least 150 millimeters into the post.

6-04.3(10) Caps

Timber caps shall rest uniformly across the tops of posts or piles and cap ends shall be aligned evenly. Each cap shall be fastened with a drift bolt 19 millimeters in diameter or larger that penetrates the post or pile at least 230 millimeters. The bolt shall be approximately in the center of the pile or post.

If the roadway grade exceeds 2 percent, each cap shall be beveled to match the grade.

6-04.3(11) Bracing

When pile bents are taller than 3 meters, each shall be braced transversely and every other pair shall be braced longitudinally. No single cross-bracing shall brace more than 6 meters of vertical distance on the piles. If the vertical distance exceeds 6 meters, more than one cross-bracing shall be used. Each brace end shall be bolted through the pile, post, or cap with a bolt 19 millimeters in diameter or larger. Other brace/pile intersections shall be bolted or boat-spiked as the Plans require. Cross-bracing shall lap both upper or lower caps and shall be bolted to the caps or sills at each end.

6-04.3(12) Stringers

All stringers that carry laminated decking or vary more than 3 millimeters in depth shall be sized to an even depth at bearing points. Outside stringers shall be butt jointed and spliced. Interior stringers shall be lapped so that each rests over the full width of the cap or floorbeam at each end. Except on sharp horizontal and vertical curves, stringers may cover two spans. In this case, joints shall be staggered and the stringers either toenailed or drift bolted as the Plans require. To permit air circulation on untreated timber structures, the ends of lapped stringers shall be separated. This separation shall be done by fastening across the lapping face a 25-millimeter by 75-millimeter wood strip cut 50 millimeters shorter than the depth of the stringer.

Any cross-bridging or solid bridging shall be neatly and accurately framed, then securely toenailed at each end (with two nails for cross-bridging and four nails for solid bridging). The Plans show bridging size and spacing.

6-04.3(13) Wheel Guards and Railings

Wheel guards and railings shall be built as Section 6-06.3(1) requires.

6-04.3(14) Single-Plank Floors

Single-plank floors shall be made of a single thickness of plank on stringers or joists. Unless the Engineer directs otherwise, the planks shall be:

1. Laid heart side down with tight joints,
2. Spiked to each joist or nailing strip with at least two spikes that are at least 100 millimeters longer than the plank thickness,
3. Spiked at least 65 millimeters from the edges,
4. Cut off on a straight line parallel to the centerline of the roadway,
5. Arranged so that no adjacent planks vary in thickness by no more than 2 millimeters, and
6. Surfaced on one side and one edge (S1S1E) unless otherwise specified.

6-04.3(15) Laminated Floors

The strips shall be placed on edge and shall be drawn down tightly against the stringer or nailing strip and the adjacent strip and, while held in place, shall be spiked. Each strip shall extend the full width of the deck, unless some other arrangement is shown in the Plans or permitted by the Engineer.

Each strip shall be spiked to the adjacent strip at intervals of not more than 0.6 meter, the spikes being staggered 200 millimeters in adjacent strips. The spikes shall be of sufficient length to pass through two strips and at least halfway through the third. In addition, unless bolting is specified in the Plans, each strip shall be toenailed to alternate stringers with 40d common nails and adjacent strips shall be nailed to every alternate stringer. The ends of all pieces shall be toenailed to the outside stringer. The ends of the strips shall be cut off on a true line parallel to the centerline of the roadway. When bolts are used to fasten laminated floors to stringers, the bolts shall be placed at the spacing shown in the Plans, and the pieces shall be drawn down tightly to the bolting strips. The bolt heads shall be driven flush with the surface of the deck. Double nuts or single nuts and lock nuts shall be used on all bolts. The strips shall be spiked together in the same manner as specified above.

6-04.3(16) Plank Subfloors for Concrete Decks

Any plank subfloor shall be laid surfaced side down with close joints at right angles to the centerline of the roadway. Planks shall be spiked in place as required in Section 6-04.3(14).

Floor planks shall be treated in accordance with Section 9-09.3.

6-04.3(17) Trusses

Completed trusses shall show no irregularities of line. From end to end, chords shall be straight and true in horizontal projection. In vertical projection they shall show a smooth curve through panel points that conforms to the correct camber. The Engineer will reject any pieces cut unevenly or roughly at bearing points. Before placement of the hand railing, the Contractor shall complete all trusses, swing them free of their falsework, and adjust them for line and camber (unless the Engineer directs otherwise).

6-04.3(18) Painting

Section 6-07.3(3) governs painting of timber structures.

6-04.4 Measurement

The criteria in Section 6-03.4 will be used to determine the mass of structural metal other than hardware.

Timber and lumber (treated or untreated) will be measured by the cubic meter, using nominal thicknesses and widths. Lengths will be actual lengths of individual pieces in the finished structure with no deduction for daps, cuts, or splices. To measure laminated timber decking, the Contracting Agency will use the number and after-dressing sizes of pieces required in the Plans. The length of each lamination shall be the length remaining in the finished structure.

6-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

1. "Timber and Lumber (untreated or name treatment)", per cubic meter.
2. "Structural Metal", lump sum.

Where no item for structural metal is included in the proposal, full pay for furnishing and placing metal parts shall be included in the unit contract price per cubic meter for "Timber and Lumber".

When no bid item is included in the proposal and payment is not otherwise provided, painting shall be considered as incidental to the construction, and all costs therefore shall be included in the unit contract prices for the payment items involved and shown.

6-05 PILING

6-05.1 Description

This work consists of furnishing and driving piles (timber, precast concrete, cast-in-place concrete, and steel) of the sizes and types the Contract or the Engineer require. This work also includes cutting off or building up piles when required. In furnishing and driving piles, the Contractor shall comply with the requirements of this section, the Contract, and the Engineer.

6-05.2 Materials

Materials shall meet the requirements of the following sections:

Reinforcing Steel	9-07
Prestressing Steel	9-07.10
Timber Piling	9-10.1
Concrete Piling	9-10.2
Cast-in-Place Concrete Piling	9-10.3
Steel Pile Tips and Shoes	9-10.4
Steel Piling	9-10.5

6-05.3 Construction Requirements

6-05.3(1) Piling Terms

Concrete Piles — Concrete piling may be precast or precast-prestressed concrete, or steel casings driven to the ultimate bearing capacity called for in the Contract which are filled with concrete (cast-in-place) after driving.

Steel Piles — Steel piles may be open-ended or closed-ended pipe piles, or H-piles.

Overdriving — Over-driving of piles occurs when the ultimate bearing capacity calculated from the equation in Section 6-05.3(12), or the wave equation if applicable, exceeds the ultimate bearing capacity required in the Contract in order to reach the minimum tip elevation specified in the Contract, or as required by the Engineer.

Maximum Driving Resistance — The maximum driving resistance is either the pile ultimate bearing capacity, or ultimate bearing capacity plus overdriving to reach minimum tip elevation as specified in the Contract, whichever is greater.

Wave Equation Analysis — Wave equation analysis is an analysis performed using the wave equation analysis program (WEAP) with a version dated 1987 or later. The wave equation may be used as specified herein to verify the Contractor's proposed pile driving system. The pile driving system includes, but is not necessarily limited to, the pile, the hammer, the helmet, and any cushion. The wave equation may also be used by the Engineer to determine pile driving criteria as may be required in the Contract.

Ultimate Bearing Capacity — Ultimate bearing capacity refers to the vertical load carrying capacity (in units of force) of a pile as determined by the equation in Section 6-05.3(12), the wave equation analysis, pile driving analyzer and CAPWAP, static load test, or any other means as may be required by the Contract, or the Engineer.

Allowable Bearing Capacity — Allowable bearing capacity is the ultimate bearing capacity divided by a factor of safety. The Contract may state the factor of safety to be used in calculating the allowable bearing capacity from the ultimate bearing capacity. In the absence of a specified factor of safety, a value of three (3) shall be used.

Rated Hammer Energy — The rated energy represents the theoretical maximum amount of gross energy that a pile driving hammer can generate. The rated energy of a pile driving hammer will be stated in the hammer manufacturer's catalog or specifications for that pile driving hammer.

Developed Hammer Energy — The developed hammer energy is the actual amount of gross energy produced by the hammer for a given blow. This value will never exceed the rated hammer energy. The developed energy may be calculated as the ram weight times the drop (or stroke) for drop, single acting hydraulic, single acting air/steam, and open-ended diesel hammers. For double acting hydraulic and air/steam hammers, the developed hammer energy shall be calculated from ram impact velocity measurements or other means approved by the Engineer. For closed-ended diesel hammers, the developed energy shall be calculated from the measured bounce chamber pressure for a given blow. Hammer manufacturer calibration data may be used to correlate bounce chamber pressure to developed hammer energy. For a single acting diesel hammer the developed energy is determined using the blows per minute.

Transferred Hammer Energy — The transferred hammer energy is the amount of energy transferred to the pile for a given blow. This value will never exceed the developed hammer energy. Factors that cause transferred hammer energy to be lower than the developed hammer energy include friction during the ram downstroke, energy retained in the ram and helmet during rebound, and other impact losses. The transferred energy can only be measured directly by use of sensors attached to the pile. A pile driving analyzer (PDA) may be used to measure transferred energy.

Pile Driving Analyzer — A pile driving analyzer (PDA) is a device which can measure the transferred energy of a pile driving system, the compressive and tensile stresses induced in the pile due to driving, the bending stresses induced by hammer mis-alignment with the pile, and estimate the ultimate capacity of a pile at a given blow.

Pile Driving System — The pile driving system includes, but is not necessarily limited to, the hammer, leads, helmet or cap, cushion and pile.

Helmet — The helmet, also termed the cap, drive cap, or driving head, is used to transmit impact forces from the hammer ram to the pile top as uniformly as possible across the pile top such that the impact force of the ram is transmitted axially to the pile. The term helmet can refer to the complete impact force transfer system, which includes the anvil or striker plate, hammer cushion and cushion block, and a pile cushion if used, or just the single piece unit into which these other components (anvil, hammer cushion, etc.) fit. The helmet does not include a follower, if one is used. For hydraulic hammers, the helmet is sometimes referred to as the anvil.

Hammer Cushion — The hammer cushion is a disk of material placed on top of the helmet but below the anvil or striker plate to relieve impact shock, thus protecting the hammer and the pile.

Pile Cushion — The pile cushion is a disk of material placed between the helmet and the pile top to relieve impact shock, primarily to protect the pile.

Follower — A follower is a structural member placed between the hammer assembly, which includes the helmet, and the pile top when the pile head is below the reach of the hammer.

Pile Driving Refusal — Pile driving refusal is defined as 15 blows per 25 millimeters for the last 100 millimeters of driving. This is the maximum blow count allowed during overdriving.

Minimum Tip Elevation — The minimum tip elevation is the elevation to which the pile tip must be driven. Driving deeper in order to obtain the required ultimate bearing capacity may be required.

6-05.3(2) Ordering Piling

The Contractor shall order all piling (except cast-in-place concrete and steel piles) from an itemized list the Engineer will provide. This list, showing the number and lengths of piles required, will be based on test-pile driving (or other) data. The list will show lengths below the cutoff point. The Contractor shall supply (and bear the cost of supplying) any additional length required for handling or driving.

The Contractor shall assume all responsibility for buying more or longer piles than those shown on the list provided by the Engineer. All piles purchased on the basis of the Engineer's list but not used in the finished structure shall become the property of the Contracting Agency. The Contractor shall deliver these as the Engineer directs. The Contractor shall keep pile cutoffs that are 2.4 meters or under and any longer ones the Contracting Agency does not require.

When ordering steel casings for cast-in-place concrete and steel piling, the Contractor shall base lengths on information derived from driving test piles and from subsurface data. The Contractor shall also select the wall thickness of steel piles or steel casings for cast-in-place piles which will be necessary to prevent damage during driving and handling. The selection of wall thickness for steel piles or steel casings shall also consider the effects of lateral pressures from the soil or due to driving of adjacent piles. Steel piles and steel casings must be strong and rigid enough to resist these pressures without deforming or distorting. The Contractor shall select the wall thickness based on information derived from test piles, subsurface data and/or wave equation analysis. Wave equation analysis is required prior to ordering piling for piles with specified ultimate bearing capacities of 2700 kiloNewtons or greater. If a wave equation analysis is performed, the Contractor shall base the selection of wall thickness on the maximum driving resistance identified in the Contract to reach the minimum tip elevation, if the maximum driving resistance is greater than the specified ultimate bearing capacity and if a minimum tip elevation is specified. The wave equation analysis shall be submitted by the Contractor as required in Section 6-05.3(9)A. The Engineer will not supply any list for piling of these types.

The Contractor shall obtain the Engineer's approval of pile dimensions before any steel casings or steel piles are ordered or shipped.

6-05.3(3) Manufacture of Precast Concrete Piling

Precast concrete piles shall consist of concrete sections reinforced to withstand handling and driving stresses. These may be reinforced with deformed steel bars or prestressed with steel strands. The Plans show dimensions and details. If the Plans require piles with square cross-sections, the corners shall be chamfered 25 millimeters.

330 millimeters diameter precast or prestressed piles shall meet the requirements of Standard Plans E-4.

400 millimeters and 460 millimeters diameter precast-prestressed piles shall meet the requirements of Standard Plans E-4a.

Temporary stress in the prestressing reinforcement of prestressed piles (before loss from creep and shrinkage) shall be 70 percent of the minimum ultimate tensile strength. (For short periods during manufacture, the reinforcement may be overstressed to 80 percent of ultimate tensile strength if stress after transfer to concrete does not exceed 70 percent of that strength.)

Prestressed concrete piles shall have a final (effective) prestress of at least 6900 kilopascals.

Unless the Engineer approves splices, all piles shall be full length.

The Contracting Agency intends to perform Quality Assurance Inspection. By its inspection, the Contracting Agency intends only to facilitate the work and verify the quality of that work. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

6-05.3(3)A Casting and Stressing

Reinforcing bars, hoops, shoes, etc. shall be placed as shown in the Contract , with all parts securely tied together and placed to the specified spacings. No concrete shall be poured until all reinforcement is in place in the forms.

The Contractor shall perform quality control inspection. The manufacturing plant for precast concrete piling shall be certified by the Precast/Prestressed Concrete Institute's Plan Certification Program for the type of precast piling to be produced and shall be approved by WSDOT as a Certified Precast Concrete Fabricator prior to start of production. WSDOT Certification will be established or renewed during the annual precast plant review and approval process.

Prior to the start of production of the piling, the Contractor shall advise the Engineer of the production schedule. The Contractor shall give the Inspector safe and free access to the work. If the Inspector observes any nonspecification work or unacceptable quality control practices, the Inspector will advise the plant manager. If the corrective action is not acceptable to the Engineer, the piling(s) will be rejected.

In casting concrete piles, the Contractor shall:

1. Cast them either vertically or horizontally;
2. Use metal forms (unless the Engineer approves otherwise) with smooth joints and inside surfaces that can be reached for cleaning after each use;
3. Brace and stiffen the forms to prevent distortion;
4. Place concrete continuously in each pile, guarding against horizontal or diagonal cleavage planes;
5. Ensure that the reinforcement is properly embedded;
6. Use internal vibration around the reinforcement during concrete placement to prevent rock pockets from forming; and
7. Cast test cylinders with each set of piles as concrete is placed.

Forms shall be metal and shall be braced and stiffened to retain their shape under pressure of wet concrete. Forms shall have smooth joints and inside surfaces easy to reach and clean after each use. That part of a form which will shape the end surface of the pile shall be a true plane at right angles to the pile axis.

Each pile shall contain a cage of nonprestressed reinforcing steel. The Contractor shall follow the Contract in the size and location of this cage, and shall secure it in position during concrete placement. Spiral steel reinforcing shall be covered by at least 40 millimeters of concrete measured from the outside pile surface.

Prestressing steel shall be tensioned as required in Section 6-02.3(25)C.

The Plans specify tensioning stress for strands or wires. Tension shall be measured by jack pressure as described in Section 6-02.3(25)C. Mechanical locks or anchors shall temporarily maintain cable tension. All jacks shall have hydraulic pressure gauges (accurately calibrated and accompanied by a certified calibration curve no more than 180 days old) that will permit stress calculations at all times.

All tensioned piles shall be pretensioned. Post-tensioning is not allowed.

The Contractor shall not stress any pile until test cylinders made with it reach a compressive strength of at least 23 megapascals.

6-05.3(3)B Finishing

As soon as the forms for precast concrete piles are removed, the Contractor shall fill all holes and irregularities with 1:2 mortar. That part of any pile that will be underground or below the low-water line and all parts of any pile to be used in salt water or alkaline soil shall receive only this mortar treatment. That part of any pile that will show above the ground or water line shall be given a Class 2 finish as described in Section 6-02.3(14)B.

6-05.3(3)C Curing

Precast Concrete Piles. The Contractor:

1. Shall keep the concrete continuously wet with water after placement for at least ten days with Type I or II Portland cement or at least three days with Type III.
2. Shall remove side forms no sooner than 24 hours after concrete placement, and then only if the surrounding air remains at no less than 10°C for five days with Type I or II Portland cement or three days with Type III.
3. May cure precast piles with saturated steam or hot air, as described in Section 6-02.3(25)D, provided the piles are kept continuously wet until the concrete has reached a compressive strength of 23 megapascals.

Precast-Prestressed Concrete Piles. These piles shall be cured as required in Section 6-02.3(25)D.

6-05.3(4) Manufacture of Steel Casings for Cast-in-place Concrete Piles

The diameter of steel casings shall be as specified in the Contract. Spiral welded steel pile casings are not allowed for steel pile casings greater that 610 millimeters in diameter. A full penetration groove weld with a maximum 2 millimeters offset between welded edges is required.

6-05.3(5) Manufacture of Steel Piles

Steel piles shall be made of rolled steel H-pile sections, steel pipe piles, or of other structural steel sections described in the Contract. Spiral welded steel pile casings are not allowed for steel pipe piles greater that 610 millimeters in diameter. A full penetration groove weld with a maximum 2 millimeters offset between welded edges is required.

6-05.3(6) Splicing Steel Casings and Steel Piles

The Engineer will normally permit steel piles and steel casings for cast-in-place concrete piles to be spliced. But in each case, the Contractor must obtain approval on the need and the method for splicing. Welded splices shall be spaced at a minimum distance of 3 meters. Only welded splices will be permitted.

Splice welds shall comply with Section 6-03.3(25) and AWS D1.1 Structural Welding Code. Splicing of steel piles shall be performed in accordance with an approved weld procedure. The Contractor shall submit a weld procedure to the Engineer for approval prior to welding. For ASTM A252 material, mill certification for each lot of pipe to be welded shall accompany the submittal.

Weld splicing of steel casings for cast-in-place concrete piles shall be the Contractor's responsibility. Casings which collapse or are not watertight, shall be replaced at the Contractor's expense.

Steel casing joints shall not be offset more than 2 millimeters.

6-05.3(7) Storage and Handling

The Contractor shall store and handle piles in ways that protect them from damage.

6-05.3(7)A Timber Piles

Timber piling shall be stacked closely and in a manner to prevent warping. The ground beneath and around stored piles shall be cleared of weeds, brush, and rubbish. Piling shall be covered against the weather if the Engineer requires it.

The Contractor shall take special care to avoid breaking the surface of treated piles. They shall be lifted and moved with equipment, tools, lifting devices which do not penetrate or damage the piles. If timber piles are rafted, any attachments shall be within 1 meter of the butts or tips. Any surface cut or break shall be repaired as per Section 9-09.3. The Engineer may reject any pile because of a cut or break.

6-05.3(7)B Precast Concrete Piles

The Contractor shall not handle any pile until test cylinders made with the same batch of concrete as the pile reach a compressive strength of at least 23 megapascals.

Storing and handling methods shall protect piles from fractures by impact and undue bending stresses. Handling methods shall never stress the reinforcement more than 83 megapascals. An allowance of twice the calculated load shall be made for impact and shock effects. The method of lifting the piles shall be submitted to the Engineer for approval. The Contractor will take extra care to avoid damaging the surface of any pile to be used in sea water or alkaline soil.

6-05.3(7)C Steel Casings and Steel Piles

The Engineer will reject bent, deformed, or kinked piles which cannot be straightened without damaging the metal.

6-05.3(8) Pile Tips and Shoes

The Contracting Agency prefers that timber piles be driven with squared ends. But if conditions require, they may be shod with metal shoes. Pile tips and shoes shall be securely attached to the piles in accordance with the manufacturer's recommendations.

Where called for in the Contract, conical steel pile tips shall be used when driving steel casings. The tips shall be inside fit, flush-mounted such that the tip and/or weld bead does not protrude more than 2 millimeters beyond the nominal outside diameter of the steel casing.

If conical tips are not specified, the lower end of each casing shall have a steel driving plate that is thick enough to keep the casing watertight and free from distortion as it is driven. The diameter of the steel driving plate shall not be greater than the outside diameter of the steel casing.

Where called for in the Contract, inside-fit cutting shoes shall be used when driving open-ended steel piles. The cutting shoes shall be flush-mounted such that the shoe and/or weld bead does not protrude more than 2 millimeters beyond the nominal outside diameter of the steel pile. The cutting shoe shall be of an inside diameter at least 19 millimeters less than the nominal inside diameter of the steel pile.

Pile tips or shoes shall be of a type denoted in the Qualified Products List. If pile tips or shoes other than those denoted in the Qualified Products List are proposed, the Contractor shall submit shop drawings of the proposed pile tip along with design calculations, specifications, material chemistry and installation requirements, to the Engineer for approval. The Contractor shall also submit evidence of a pile driving test demonstrating suitability of the proposed pile tip. The test shall be performed in the presence of the Engineer or an acceptable independent testing agency. The test shall consist of driving a pile fitted with the proposed tip. If the pile cannot be visually inspected (see Section 6-05.3(11)F), a sacrificial pile fitted with the proposed tip shall be driven outside the

proposed foundation limits. The pile shall be driven to a depth sufficient to develop the required ultimate bearing capacity as called for in the Contract, in ground conditions determined to be equivalent to the ground conditions at the project site. For closed-ended casings or piles, the pile need not be removed if, in the opinion of the Engineer, the pile can be inspected for evidence of damage to the pile or the tip. For open-ended steel casings or piles, timber piles or H-piles, the pile shall be removed for inspection.

6-05.3(9) Pile Driving Equipment

6-05.3(9)A Pile Driving Equipment Approval

Prior to driving any piles, the Contractor shall submit to the Engineer for approval the details of each proposed pile driving system. The pile driving system shall meet the minimum requirements for the various combinations of hammer type and pile type specified in this Section. These requirements are minimums and may need to be increased in order to ensure that the required ultimate bearing capacity can be achieved, that minimum tip elevations can be reached, and to prevent pile damage.

The Contractor shall submit a wave equation analysis for all pile driving systems used to drive piling with required ultimate bearing capacities of 2700 kiloNewtons or greater. The wave equation analysis shall be performed by, and bear the stamp of, a civil engineer licensed in the State of Washington. The wave equation analysis shall be performed in accordance with the requirements of this section and the user's manual for the program. The wave equation analysis shall verify that the pile driving system proposed does not produce stresses greater than 90 percent of the yield stress for steel piles, or steel casings for cast-in-place concrete piles. For prestressed concrete piles, the allowable driving stress shall be $0.25\sqrt{f_c'}$ plus prestress in tension, and $0.85f_c'$ minus prestress in compression. For precast concrete piles which are not prestressed, the allowable driving stress shall be 70 percent of the yield stress of the steel reinforcement in tension, and $0.85f_c'$ in compression. The wave equation shall also verify that the pile driving system does not exceed the refusal criteria at the depth of penetration anticipated for achieving the required ultimate bearing capacity and minimum tip elevation. Furthermore, the wave equation analysis shall verify that at the maximum driving resistance specified in the Contract, the driving resistance is 100 blows per 0.3 meter or less. Unless otherwise specified in the Contract, or directed by the Engineer, the following default values shall be used as input to the wave equation analysis program:

Output option (IOUT)	0
Factor of safety applied to (R_{ult})	1.0
Type of damping	Smith
Residual stress option	No

R_{ult} is equal to the maximum driving resistance for the pile

Hammer Efficiencies:	**For Analysis of Driving Resistance**	**For Analysis of Driving Stresses**
Single acting diesel hammers	0.72	0.84
Closed-ended diesel hammers	0.72	0.84
Single acting air/steam hammers	0.60	0.70
Double acting air/steam hammers	0.45	0.53
Hydraulic hammers or other external combustion hammers having ram velocity monitors that may be used to assign an equivalent stroke.	0.85	1.00

Within 15 working days after the Engineer receives the submittal, the Contractor will be notified of the Engineer's acceptance or rejection. If the Contractor wishes to change the pile driving system after the Contractor's proposed system has been approved, the system must be submitted for approval to the Engineer, and up to an additional 10 working days for approval will be required.

6-05.3(9)B Pile Driving Equipment Minimum Requirements

For each drop hammer used, the Contractor shall weigh it in the Engineer's presence or provide the Engineer with a certificate of its mass. The exact mass shall be stamped on the hammer. Drop hammers shall weigh not less than:

1. 13 kiloNewtons for piles under 15 meters long that have an ultimate bearing capacity of not more than 530 kiloNewtons, and
2. 18 kiloNewtons for piles 15 meters and longer or that have an ultimate bearing capacity of 530 to 800 kiloNewtons.

If a drop hammer is used for timber piles, it is preferable to use a heavy hammer and operate with a short drop.

For each diesel, hydraulic, steam, or air-driven hammer used, the Contractor shall provide the Engineer with the manufacturer's specifications and catalog cuts. These documents shall show all data needed to calculate the developed energy of the hammer used.

Underwater hammers may be used only with approval of the Engineer.

Drop hammers on timber piles shall have a maximum drop of 3 meters. Drop hammers shall not be used to drive timber piles that have ultimate bearing capacities of more than 530 kiloNewtons.

When used on timber piles, diesel, hydraulic, steam, or air-driven hammers shall provide at least 17.6 kiloNewton·meters of developed energy per blow. The ram of any diesel hammer shall weigh at least 12 kiloNewtons.

Precast concrete and precast-prestressed concrete piles shall be driven with a single-acting steam, air, hydraulic, or diesel hammer with a ram mass of at least half as much as the mass of the pile, but never less than the minimums stated below. The ratio of developed hammer energy to ram mass (in kiloNewtons) shall not exceed six. Steel casings for cast-in-place concrete, steel pipe, and steel H-piles shall also be driven with diesel, hydraulic, steam, or air hammers. These hammers shall provide at least the following developed energy per blow:

Minimum Developed Energy per Blow (kN·m)

Maximum Driving Resistance (kN)	Open Ended Air or Steam Hammers	Closed Ended Diesel Hammers	Diesel Hammers	Hydraulic Hammers
Up to 1,500	29.0	31.0	40.5	25.0
1,501 to 1,900	37.0	40.0	51.5	32.0
1,901 to 2,700	52.5	56.0	73.0	45.5
2,701 to 4,000	79.5	85.0	109	68.0

In addition, the ram of any diesel or hydraulic hammer shall have the following minimum masses:

Maximum Driving Resistance (kN)	Minimum Ram Mass (kg)
Up to 1,500	1125
1,501 to 1,900	1815
1,901 to 2,700	2268
2,701 to 4,000	2948

These requirements for minimum hammer size may be waived if to the satisfaction of the Engineer a wave equation analysis is performed which demonstrates the ability of the hammer to obtain the required ultimate bearing capacity and minimum tip elevation without damage to the pile.

Vibratory hammers may be used to drive piles provided the location and plumbness requirements of this section are met. The required ultimate bearing capacity for all piles driven with vibratory hammers will be determined according to 6-05.3(12) by driving the pile at least an additional 0.6 meter using an impact hammer that meets the requirements stated above. This method of determining bearing capacity will be acceptable provided the blows per 25 mm are either constant or increasing. If the pile cannot be driven 0.6 m, the pile will be considered acceptable for bearing if the pile is driven to refusal.

If water jets are used, the number of jets and water volume and pressure shall be enough to erode the material next to the pile at the tip. The equipment shall include a minimum of two water-jet pipes and two 19 millimeter jet nozzles. The pump shall produce a constant pressure of at least 690 kilopascals at each nozzle.

6-05.3(9)C Pile Driving Leads

All piles shall be driven with fixed-lead drivers. The leads shall be fixed on the top and bottom during the pile driving operation. Leads shall be long enough to eliminate the need for any follower (except for timber piles as specified in Section 6-05.3(11)E). To avoid bruising or breaking the surface of treated timber piles, the Contractor shall use spuds and chocks as little as possible. In building a trestle or foundation with inclined piles, leads shall be adapted for driving batter piles.

A helmet of the right size for the hammer shall distribute the blow and protect the top of steel piling or casings from driving damage. The helmet shall be positioned symmetrically below the hammer's striking parts, so that the impact forces are applied concentric to the pile top.

Pile driving leads other than those fixed at the top and bottom may be used to complete driving, if approved by the Engineer, when all of the following criteria are met:

1. Each plumb and battered pile is located and initially driven at least 6 meters in true alignment using fixed leads or other approved means.
2. The pile driving system (hammer, cushion and pile) will be analyzed by Pile Driving Analyzer (PDA) to verify driving stresses in the pile are not increased due to eccentric loading during driving, and transferred hammer energy is not reduced due to eccentric loading during driving, for all test piles and at least one production pile per pier. Unless otherwise specified, the cost of PDA testing shall be incidental to the various unit contract prices for driving piles.

6-05.3(10) Test Piles

If the Contract or the Engineer call for it, the Contractor shall drive test piles to determine pile lengths required to reach the required ultimate bearing capacity, penetration, or both. Test piles shall be:

1. Made of the same material and have the same tip diameter as the permanent piles (although test piles for treated timber piles may be either treated or untreated),
2. Driven with pile tips if the permanent piles will have tips,
3. Prebored when preboring is specified for the permanent piles,
4. Identical in cross-section and other characteristics to the permanent piles when the test piles are steel casings for cast-in-place concrete piles, precast concrete, precast-prestressed concrete or steel pipe or H-pile,
5. Long enough to accommodate any soil condition,
6. Driven with equipment and methods identical to those to be used for the permanent piles,
7. Located as the Engineer directs, and
8. Driven before permanent piles in a given pier.

Test piles may also be driven by the Contractor (at no cost to the Contracting Agency) as evidence that the pile driving system selected will not damage the pile or result in refusal prior to reaching any specified minimum tip elevation.

Timber test piles shall be driven outside the footing and cut off 0.3 meter below the finished ground line. Timber test piles shall not be used in place of permanent piles.

Steel and all types of concrete test piles shall become permanent piles. The Contracting Agency has reduced the number of permanent piles by the number of test piles.

The Contractor shall base test pile length on test-hole data in the contract. Any test piles that prove to be too short shall be replaced (or spliced if the Contract allows splicing) at the Contractor's expense.

In foundations and trestles, test piles shall be driven to at least 15 percent more than the ultimate bearing capacity required for the permanent piles, except where pile driving criteria is determined by the wave equation. When pile driving criteria is specified to be determined by the wave equation, the test piles shall be driven to the same ultimate bearing capacity as the production piles. Test piles shall penetrate at least to any minimum tip elevation specified in the Contract. If no minimum tip elevation is specified, test piles shall extend at least 3 meters below the bottom of the concrete footing or groundline, and 5 meters below the bottom of the concrete seal.

When any test pile to be left as a permanent pile has been so damaged by handling or driving that the Engineer believes it unfit for use, the Contractor shall remove and replace the pile at no additional cost to the Contracting Agency. The Engineer may direct the Contractor to overdrive the test pile to more than 15 percent above the ultimate bearing capacity for permanent piles, or if the wave equation is used to determine driving criteria, the Engineer may direct the Contractor to overdrive the test pile above the ultimate bearing capacity. In these cases, the overdriving shall be at the Contractor's expense. But if pile damage results from this overdriving, any removal and replacement will be at the Contracting Agency's expense.

6-05.3 (11) Driving Piles

6-05.3(11)A Tolerances

For elevated pier caps, the tops of piles at cut-off elevation shall be within 50 millimeters of the locations indicated in the Contract. For piles capped below final grade, the tops of piles at cut-off elevation shall be within 150 millimeters of the horizontal locations indicated in the Contract. No pile edge shall be nearer than 100 millimeters from the edge of any footing or cap. Piles shall be installed such that the axial alignment of the top 3 meters of the pile is within 4 percent of the specified alignment. No misaligned steel or concrete

piles shall be pulled laterally. A properly aligned section shall not be spliced onto a misaligned section for any type of pile. Unless the Contract shows otherwise, all piles shall be driven vertically.

6-05.3(11)B Foundation Pit Preparation

The Contractor shall replace (and bear the cost of replacing) any pile damaged or destroyed before or during driving.

The Contractor shall completely dig all foundation pits (and build any required cofferdams or cribs) before driving foundation piles. The Contractor shall adjust pit depths to allow for upheaval caused by pile-driving, judging the amount of adjustment by the nature of the soil. Before constructing the footing or pile cap, the Contractor shall restore the pit bottom to correct elevation by removing material or by backfilling with granular material.

6-05.3(11)C Preparation for Driving

Treated and untreated timber piles shall be freshly cut square on the butt ends just before they are driven. If piles will be driven into hard material, caps, collars, or bands shall be placed on the butt ends to prevent crushing or brooming. If the head area of the pile is larger than that of the hammer face, the head shall be snipped or chamfered to fit the hammer. On treated piles, the heads shall be snipped or chamfered to at least the depth of the sapwood to avoid splitting the sapwood from the pile body.

The Contractor shall match timber pile sizes in any single bent to prevent sway braces from undue bending or distorting.

When driven, pile faces shall be turned as shown in the Plans or as the Engineer directs.

No precast-prestressed pile shall be driven until test cylinders poured with it reach at least the specified compressive strength shown in the Contract. On all other precast piles, the cylinders must reach a compressive strength of at least 28 megapascals before the piles are driven.

Helmets of approved design shall protect the heads of all precast concrete piles as they are driven. Each helmet shall have fitted into it a cushion next to the pile head. The bottom side of the helmet shall be recessed sufficiently to accommodate the required pile cushion and hold the pile in place during positioning and driving. The inside helmet diameter shall be determined before casting the pile, and the head of the pile shall be formed to fit loosely inside the helmet.

Steel Casing, steel pipe or H-piles shall have square-cut ends.

6-05.3(11)D Achieving Minimum Tip Elevation and Bearing

Once pile driving has started, each pile shall be driven continuously until the required ultimate bearing capacity shown in the contract has been achieved. Pauses during pile driving, except for splicing, mechanical breakdown, or other unforeseen events, shall not be allowed.

If the Contract specifies a minimum tip elevation, the pile shall be driven to at least the minimum tip elevation, even if the ultimate bearing capacity has been achieved, unless the Engineer directs otherwise. If a pile does not develop the required ultimate bearing capacity at the minimum tip elevation, the Contractor shall continue driving the pile until the required bearing capacity is achieved. If no minimum tip elevation is specified, then the piles shall be driven to the ultimate bearing capacity shown in the Contract and the following minimum penetrations:

Pile supporting cross-beams, bents, elevated pile caps	3 meters below final top of ground elevation
Piles supporting foundations	3 meters below bottom of foundation
Piles with a concrete seal	5 meters below bottom of seal

If overdriving is required in order to reach a specified minimum tip elevation, the Contractor shall provide a pile driving system which will not result in damage to the pile or refusal before the minimum tip elevation is reached. The cost of overdriving shall be incidental to the various unit contract prices for furnishing and driving piles.

So long as the pile is not damaged and the embankment or foundation material being driven through is not permanently damaged, the Contractor shall use normal means necessary to:

1. Secure the minimum depth specified,
2. Penetrate hard material that lies under a soft upper layer,
3. Penetrate through hard material to obtain the specified minimum tip elevation, or
4. Penetrate through a previously placed embankment.

Normal means refer to methods such as preboring, spudding, or jetting piles. Blasting or drilling through obstructions are not considered normal means.

Prebored holes and pile spuds shall have a diameter no larger than the least outside dimension of the pile. After the pile is driven, the Contractor shall fill all open spaces between the pile and the soil caused by the preboring or spudding with dry sand, or pea gravel, or controlled density fill as approved by the Engineer.

If water jets are used, the jets shall be withdrawn before the pile reaches its final penetration, and the pile shall then be driven to its final penetration and ultimate bearing capacity. The pile shall be driven a minimum of 0.6 meter to obtain the ultimate bearing capacity after the jets are withdrawn, or to refusal, whichever occurs first. If the water jets loosen a pile previously driven, it shall be redriven in place or pulled and replaced by a new pile. To check on pile loosening, the Contractor shall attempt to redrive at least one in every five piles, but no less than one pile per bent or pier.

The various unit contract prices for driving piles shall cover all costs related to the use of water jets, preboring, or spudding. The Contracting Agency will not pay any costs the Contractor incurs in redriving piles loosened as a result of using water jets, preboring, or spudding.

If the Engineer requires, the Contractor shall overdrive the pile beyond the ultimate bearing capacity and minimum tip elevation shown in the Contract. In this case, the Contractor will not be required to:

1. Use other than normal means to achieve the additional penetration;
2. Bear the expense of removing or replacing any pile damaged by overdriving; or
3. Bear the expense of overdriving the pile more than 1 meter as specified in Section 6-05.5.

In driving piles for footings with seals, the Contractor shall use no method (such as jetting or preboring) that might reduce friction capacity.

6-05.3(11)E Use of Followers for Driving

Followers shall not be used to drive concrete or steel piles. On timber piles, the Contractor may use steel (not wooden) followers if the follower fits snugly over the pile head. If a follower is used, the Contractor shall, in every group of 10 piles, drive one long pile without a follower, but no less than one pile per bent or pier, to the required ultimate bearing capacity and minimum tip elevation. This long pile shall be used to test the bearing

capacity of the piles driven with a follower in the group. The tip elevation of the long pile shall be similar to the elevation of the piles driven with the follower. If the tip elevations are significantly different, as determined by the Engineer, the Contractor shall redrive the remaining piles in the group to the tip elevation of the longer pile.

6-05.3(11)F Pile Damage

The Contractor shall remove and replace (and bear the cost of doing so) any pile which is damaged as determined by the Engineer.

After driving a steel casing for a cast-in-place concrete pile, the Contractor shall leave it empty until the Engineer has inspected and approved it. The Contractor shall make available to the Engineer a light suitable for inspecting the entire length of its interior. The Engineer will reject any casing that is improperly driven, that shows partial collapse that would reduce its ultimate bearing capacity, or that has been reduced in diameter, or that will not keep out water. The Contractor shall replace (and bear the cost of replacing) any rejected casing.

Pile heads which have been broomed, rolled, or otherwise significantly damaged as determined by the Engineer shall be cut back to undamaged material before proceeding with driving as well as final acceptance of the pile.

6-05.3(11)G Pile Cutoff

The Contractor shall trim the tops of all piles to the true plane shown in the Contract and to the elevation the Engineer requires. If a pile is driven below cutoff elevation without the Engineer's approval, the Contractor shall remove and replace it (and bear the costs of doing so), even if this requires a longer pile. Any pile that rises as nearby piles are driven, shall be driven down again if the Engineer requires.

Any piles under timber caps or grillages shall be sawed to the exact plane of the structure above them and fit it exactly. No shimming on top of timber piles to adjust for inaccurate pile top elevations will be permitted. If a timber pile is driven out of line, it shall be straightened without damage before it is cut off or braced.

Steel casing shall be cut off at least 150 millimeters below the finished ground line or at the low water line if the casing will be visible as determined by the Engineer.

6-05.3(11)H Pile Driving From or Near Adjacent Structures

The Contractor shall not drive piling from an existing structure unless all of the following conditions are met:

1. The existing structure will be demolished within the contract.
2. The existing structure is permanently closed to traffic, and
3. Working drawings are submitted in accordance with Sections 6-01.9 and 6-02.3(16), showing the structural adequacy of the existing structure to safely support all of the construction loads.

To minimize the detrimental effects of pile driving vibrations on new concrete less than 28 days old, piles shall not be driven closer to the new concrete than the distance determined from the following formula:

D = C times the square root of E

Where: D = distance in meters
E = rated hammer energy in kiloNewtons-meters
C = coefficient shown below based on the number of days of curing time

Curing Time (days)	Coefficient (C)	Curing Time (days)	Coefficient (C)
1	2.81	6	0.99
2	1.90	7-9	0.91
3	1.49	10-13	0.83
4	1.24	14-20	0.75
5	1.08	21-28	0.66

This distance may be reduced if approved in writing by the Engineer.

6-05.3(12) Determination of Ultimate Bearing Capacity

The following formula shall be used to determine ultimate bearing capacity:

P = F x E x Ln(10N)

Where:
- P = ultimate bearing capacity, in kiloNewtons
- F = 11 for air/steam hammers
  - = 10 for open ended diesel hammers
  - = 7.9 for closed ended diesel hammers
  - = 13 for hydraulic hammers
  - = 4.0 for drop hammers
- E = developed energy, equal to W times H[1], in kiloNewtons-meters
- W = weight of ram, in kiloNewtons
- H = vertical drop of hammer or stroke of ram, in meters
- N = average penetration resistance in blows per 25 mm for the last 100 millimeters of driving
- Ln = the natural logarithm, in base “e”

[1]For closed-end diesel hammers (double-acting), the developed hammer energy (E) is to be determined from the bounce chamber reading. Hammer manufacturer calibration data may be used to correlate bounce chamber pressure to developed hammer energy. For double acting hammer hydraulic and air/steam hammers, the developed hammer energy shall be calculated from ram impact velocity measurements or other means approved by the Engineer. For open ended diesel hammers (single-acting) use the blows per minute to determine the developed energy (E).

The above formula applies only when:

1. The hammer is in good condition and operating in a satisfactory manner;
2. A follower is not used;
3. The pile top is not damaged;
4. The pile head is free from broomed or crushed wood fiber;
5. The penetration occurs at a reasonably quick, uniform rate; and the pile has been driven at least 0.6 meter after any interruption in driving greater than 1 hour in length.
6. There is no perceptible bounce after the blow. If a significant bounce cannot be avoided, twice the height of the bounce shall be deducted from “H” to determine its true value in the formula.
7. For timber piles, bearing capacities calculated by the formula above shall be considered effective only when it is less than the crushing strength of the piles.
8. If “N” is greater than or equal to 1.0 blow/25 millimeters.

If "N" required to achieve the required ultimate bearing capacity using the above formula is less than 1.0 blow/25 millimeters, the pile shall be driven until the penetration resistance is a minimum of 1.0 blow/25 millimeters for the last 0.6 meter of driving.

The Engineer may require the Contractor to install a pressure gauge on the inboard end of the hose to check pressure at the hammer.

If water jets are used in driving, bearing capacities shall be determined either: (1) by calculating it with the driving data and the formula above after the jets have been withdrawn and the pile is driven at least 0.6 meter, or (2) by applying a test load.

6-05.3(13) Treatment of Timber Pile Heads

After cutting timber piles to correct elevation, the Contractor shall thoroughly coat the heads of all untreated piles with two coats of an approved preservative that meets the requirements of Section 9-09 (except concrete-encased piles).

After cutting treated timber piles to correct elevation, the Contractor shall brush three coats of an approved preservative that meets the requirements of Section 9-09 on all pile heads (except those to be covered with concrete footings or concrete caps). The pile heads shall then be capped with alternate layers of an approved roofing asphalt and a waterproofing fabric that conforms to Section 9-11.2. The cap shall be made of four layers of an approved roofing asphalt and three layers of fabric. The fabric shall be cut large enough to cover the pile top and fold down at least 150 millimeters along all sides of the pile. After the fabric cover is bent down over the pile, its edges shall be fastened with large-head galvanized nails or with three turns of galvanized wire. The edges of the cover shall be neatly trimmed.

On any treated timber pile encased in concrete, the cut end shall receive two coats of an approved preservative that meets the requirements of Section 9-09 and then a heavy coat of an approved roofing asphalt.

6-05.3(14) Extensions and Build-ups of Precast Concrete Piles

The Contractor shall add extensions, or build-ups (if necessary) on precast concrete piles after they are driven to the required ultimate bearing capacity and minimum tip elevation.

Before adding extensions or build-ups to precast-prestressed piles, the Contractor shall remove any spalled concrete, leaving the pile fresh-headed and with a top surface perpendicular to the axis of the pile. The concrete in the build-up shall be Class 35.

Before adding to non-prestressed precast concrete piles, the Contractor shall cut the pile head away to a depth 40 times the diameter of the vertical reinforcing bar. The final cut shall be perpendicular to the axis of the pile. Reinforcement of the same density and configuration as used in the pile shall be used in the build-up and shall be fastened firmly to the projecting steel. Forms shall be placed to prevent concrete from leaking along the pile. The concrete in the build-up shall be Class 28.

Just before placing the concrete for extensions or build-ups to precast or precast-prestressed concrete piles, the Contractor shall thoroughly wet the top of the pile. Forms shall remain in place at least three days.

6-05.3(15) Completion of Cast-In-Place Concrete Piles

After approval by the Engineer, driven casings shall be cut off horizontally at the required elevation. They shall be clean and free of water when concrete and reinforcing steel are placed.

These piles shall consist of steel casings driven into the ground, reinforced as specified, and filled with Class 28P concrete.

6-05.3(15)A Reinforcement

All bars shall be fastened rigidly into a single unit, then lowered into the casing before the concrete is placed. Loose bars shall not be used.

Spiral hooping reinforcement shall be deformed steel bar, plain steel bar, cold-drawn wire, or deformed wire.

6-05.3(15)B Placing Concrete

Before placing concrete, the Contractor shall remove all debris and water from the casing. If the water cannot be removed, the casing shall be removed (or cut off 0.6 meters below the ground and filled with sand) and a new one driven.

The Contractor shall place concrete continuously through a 1.5 meter rigid conduit directing the concrete down the center of the pile casing, ensuring that every part of the pile is filled and the concrete is worked around the reinforcement. The top 1.5 meters of concrete shall be placed with the tip of the conduit below the top of fresh concrete. The Contractor shall vibrate, as a minimum, the top 3 meters of concrete. In all cases the concrete shall be vibrated to a point at least 1.5 meters below the original ground line.

6-05.4 Measurement

Measurement for driving (type) pile will be the number of piles driven in place.

In these categories, measurement will be the number of linear meters driven below cutoff or as shown in the Engineer's order list:

1. Furnishing timber piling (untreated or name of treatment).
2. Precast concrete and precast-prestressed concrete piling.

In these categories, measurement will be the number of linear meters driven below cutoff, but no Engineer's order list will be provided:

1. Cast-in-place concrete piling.
2. Furnishing steel piling.

Measurement for furnishing and driving test piles will be the number actually furnished and driven as the Contract requires.

Measurement for steel pile tips or shoes will be by the number of tips or shoes actually installed and driven in place on steel casings or steel piles.

6-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Furnishing and Driving (type) Test Pile", per each.

The unit contract price per each for "Furnishing and Driving (type) Test Pile" shall be full pay for furnishing and driving test piles to the ultimate bearing capacity or penetration required by the Engineer, furnishing and installing a pile tip when pile tips are specified for the permanent piles, preboring when preboring is specified for the permanent piles, for pulling the piles or cutting them off as required, and for removing them from the site or for delivery to the Contracting Agency for salvage when ordered by the Engineer. This price shall also include all costs in connection with moving all pile driving equipment or other necessary equipment to the site of the work and for removing all such equipment from the site after the piles have been driven. If, after the test piles have been driven, it is found necessary to eliminate the piling from all or any part of the structure, no additional pay will be allowed for moving the pile driving equipment to and from the site of the work.

"Driving Timber Pile (untreated or name treatment)", per each.

The unit contract price per each for "Driving Timber (type) Pile" shall include any metal shoes which the Contractor has determined to be beneficial to the pile driving.

"Driving Conc. Pile (size)", per each.

"Driving St. Pile", per each.

The unit contract price per each for "Driving (type) Pile (____)" shall be full pay for driving the pile to the ultimate bearing and/or penetration specified. When overdriving piles beyond the ultimate bearing capacity and minimum tip elevation specified in the Contract is required by the Engineer, payment for the first 1 meter of overdriving will be included in the unit contract price for "Driving (type) Pile". Additional penetration beyond the first 1 meter of overdriving will be paid for on the basis of force account work as covered in Section 1-09.6.

"Furnishing Timber Piling (untreated or name treatment)", per linear meter.

"Furnishing Conc. Piling (size)", per linear meter.

"Furnishing St. Piling", per linear meter.

The unit contract price per linear meter for "Furnishing (type) Piling (____)" shall be full pay for furnishing the piling specified. Such price shall also be full pay, when measurement includes, for piling length ordered but not driven.

Precast Concrete Pile Buildup", per each.

Payment for build-ups of precast or precast-prestressed concrete piles will be made on the basis of force account work as covered in Section 1-09.6. No payment will be made for build-ups or additional lengths of build-up made necessary because of damage to the piling during driving. The length of splice for precast concrete piles includes the length cut off to expose reinforcing steel for the splice. The length of splice for precast-prestressed piles includes the length in which holes are drilled and reinforcing bars are grouted.

"Furnishing Steel Pile Tip or Shoe (size)", per each.

6-06 BRIDGE RAILINGS

6-06.1 Description

This section applies to providing and building bridge railings that meet the requirements of the Plans, these Specifications, and the Engineer.

6-06.2 Materials

Material shall meet the requirements of the following sections:

Timber Railing	9-09
Metal Railing	Plans and/or Special Provisions

6-06.3 Construction Requirements

6-06.3(1) Timber Railings

Wheel guards and railings shall be true to line and grade and framed accurately. The Contractor shall follow Section 6-04 whenever this subsection does not specify a construction method.

Unless the Plans show otherwise, wheel guards shall be:

1. Beveled and surfaced on the roadway side and surfaced on the top edge. They may be surfaced on four sides (S4S).
2. Laid in sections at least 3.7 meters long.
3. Bolted through the floor plank and outside stringer (or nailing piece) with 20-millimeter diameter bolts spaced no more than 1.2 meters apart.

All rails and rail post material shall be S4S and painted as required in Section 6-07. Railing members shall be fastened securely together, with the bolts tightened once at installation and again just before the Contracting Agency's final acceptance of the contract.

6-06.3(2) Metal Railings

Metal railing includes posts, web members, and horizontal members of the sidewalk and roadway railing. Unless the Plans or Special Provisions show otherwise, these shall be made of aluminum alloy or steel.

Before fabricating the railing, the Contractor shall submit six copies of the shop plans for the Engineer's approval. The Contractor may substitute other rail connection details for those shown in the Plans if details of these changes show in the shop plans and if the Engineer approves. In approving shop plans, the Engineer indicates only that they are adequate and complete enough. Approval does not indicate a check on dimensions.

Anchor bolts or wedge anchors shall be positioned with a template to ensure that bolts match the hole spacings of the bottom channels or anchorage plates.

Where specified, cover plates shall fit the bottom channel tightly after being snapped into position.

Metal railings shall be installed true to line and grade (or camber). After first setting the railing, the Contractor shall readjust all or part of it, if necessary, to create an overall line and grade pleasing to the eye.

6-06.4 Measurement

Timber railing will be measured by the cubic meter as shown in Section 6-04.

Metal railing will be measured by the meter along the line and slope at the base of the completed railing.

6-06.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Timber and Lumber (untreated or name treatment)", per cubic meter.

"Bridge Railing Type .____", per meter.

In case no item is included in the contract for "Bridge Railing Type ____" and payment is not otherwise provided, all metal railings shall be included in the lump sum contract price for "Structural Carbon St." as specified in Section 6-03.

6-07 PAINTING

6-07.1 Description

This work shall consist of surface preparation, containing, testing and disposing of surface preparation debris, furnishing and applying paint, shielding adjacent areas from unwanted paint, and cleaning up after painting is completed. The work shall comply with all requirements of the Plans, these Specifications, and the Engineer.

6-07.2 Materials

Paint materials shall comply with the requirements in Section 9-08.

Material used for field abrasive blasting shall meet Military Specification MIL-A-22262A(SH) as listed on QPL-22262-15 as maintained by the Department of the Navy. The Contractor shall provide the Engineer with certified test results from the abrasive blast media manufacturer showing that the abrasive blast material meets the Military Specification. In addition, the Contractor shall blend an additive with the abrasive blast media that renders the blast residual to a non-hazardous waste condition.

6-07.3 Construction Requirements

6-07.3(1) Painting New Steel Structures

All material classified as structural steel shall be painted with a shop applied, inorganic zinc silicate primer, followed by a field applied two coat paint system after field erection, cleaning, and spot priming have been completed. Except as otherwise specified, all steel surfaces shall be painted with three coats of paint. Steel surfaces embedded in concrete and faying (contact) surfaces of bolted connections (including all surfaces internal to the connection and all filler plates) shall receive the prime coat only. Stainless steel surfaces shall not be painted. Galvanized surfaces shall not be painted unless specified in the Plans or Special Provisions. Painting of galvanized surfaces, if so specified, shall be in accordance with Section 6-07.3(4).

The painting system shall consist of three coats as follows:

	Method A	**Method B**
Primer Coat	inorganic zinc	A-11-99 Shop applied
2nd Coat	epoxy	B-11-99 Field applied
3rd Coat	aliphatic urethane	C-11-99 Field applied

Once a paint system has been selected, that system shall be used throughout the structure.

Terminology used herein is in accordance with the definitions used in Volume 2, Systems and Specifications of the SSPC Steel Structures Painting Manual, 1982 Edition.

Prior to any coating materials being utilized, the Contractor shall submit the product data sheets to the Engineer for approval. The product data sheets shall include all application instructions including the mixing and thinning directions, the recommended spray nozzles and pressures, the minimum and maximum drying time between coats, friction coefficient of the faying surface, restrictions on temperature and humidity, and the repair procedures. In addition, the Contractor shall submit to the Engineer for approval an abrasive blast procedure. The procedure shall include the type of equipment and abrasive media to be used.

Paint formulations to be used on faying surfaces shall be Class B coatings with a mean slip coefficient not less than 0.50. The slip coefficient shall be determined by testing in accordance with "Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as adopted by the Research Council on Structural Connections. Test results and the paint manufacturer's Certificate of Compliance shall be submitted to the Engineer for approval with the structural steel shop drawings.

For contracts in which more than 10 tonnes of steel are to be painted, the manufacturer of the paint system shall have a technical representative present at the job site for the first day of painting. After the first day of painting the technical representative shall remain available for contact in the event of technical difficulties in applying the paint system.

During fabrication and shop painting, the Contractor shall provide access meeting the approval of the Engineer to permit inspection of the steel. The access shall not mar or damage any freshly painted surfaces.

The Contractor shall select a primer from one of the approved products listed in the Qualified Products List. The field applied primer, the second coat and the third coat shall all be selected from the same manufacturer from one of the approved coating systems listed in the Qualified Products List.

The color for the second coat shall be a contrasting color to the third coat. The color for the third coat shall be as specified in the Special Provisions.

Steel surfaces shall be:

For Method A:

1. Greater than 7C and at least 3C above the dew point, and
2. Less than 46C.

For Method B:

1. Greater than 3C and
2. Less than 46C

6-07.3(1)A Preparation for Shop Coating

A 25 micrometer minimum roughened surface profile shall be provided by an abrasive blasting procedure as approved by the Engineer. The steel surfaces shall be cleaned to a near white condition as per SSPC-SP10.

After being thoroughly cleaned by abrasive blasting as specified above, all structural steel shall be primed within the same working day on which abrasive blasting takes place, and before any rust forms, by spraying with a full coat of inorganic zinc silicate paint. High strength field bolts need not be painted before erection.

Care shall be taken to protect freshly coated surfaces from subsequent abrasive blast cleaning operations. Primed surfaces which are damaged by abrasive blasting shall be thoroughly wire brushed or, if visible rust occurs, re-blasted to a near-white (SSPC-SP10) condition. The wire brushed or abrasive blast cleaned surfaces shall be vacuumed and re-primed by spraying.

6-07.3(1)B Mixing and Thinning the Shop and Field Coatings

The coating shall be mixed with a high shear mixer in accordance with the manufacturer's written recommendations to a smooth, lump-free consistency. Paddle mixers or paint shakers are not allowed. Mixing shall be done, to the extent possible, in the original containers and shall be continued until all of the metallic powder or pigment is in suspension. The mixed coating shall be kept under continuous agitation up to and during the time of application.

In general, the coatings are supplied for use without requiring thinning. If it is necessary to thin the coating for proper application in cool weather, or to obtain better coverage of the urethane coat, the thinning shall be done in accordance with the manufacturer's written recommendations.

6-07.3(1)C Applying The Shop Coating

After the surface to be coated has been cleaned, and has received the Engineer's approval, the primer coat shall be applied so as to produce a uniform, even coating that has fully bonded with the metal.

The coatings shall be applied with the spray nozzles and pressures recommended by the manufacturer of the paint system, so as to attain the film thicknesses specified.

The top surfaces of the top flanges of the steel girders shall not be primed until the welded shear connectors are placed, unless the welded shear connectors are to be placed in the field. Welded shear connectors are not required to be painted except for the weld area.

If the welded shear connectors are to be placed in the field, the area to be welded shall be cleaned of primer by abrasive grinding just prior to welding. After welding, the ground area and the weld shall be cleaned and primed. Surfaces which are inaccessible for painting after erection shall be painted with the two field coats of paint before erection.

Dry film thickness measurements will be made in accordance with Section 6-07.3(5).

6-07.3(1)D Field Coating After Erection

When the erection work has been completed, including all connections and the straightening of any bent metal, all steel surfaces and bolts shall be prepared for painting. All adhering scale, dirt, grease, form oil, or other foreign matter shall be removed by appropriate means and all rusted or uncoated areas including the bolts, nuts, washers and splice plates shall be abrasive blasted to a near-white (SSPC-SP10) condition. All uncoated areas shall be field primed with an organic zinc paint coating selected from the same approved coating system and paint manufacturer as the other coatings for the structure.

After all field priming has been completed the surfaces shall be prepared to receive the final two field coats. The intermediate coat shall be mixed and applied per the manufacturer's written recommendations. The top coat shall also be mixed and applied per the manufacturer's written recommendations. The minimum drying time between coats shall be as shown in the approved product data sheets, but not less than 12 hours. Depending on site conditions, additional time may be required for proper curing before applying succeeding coats. The Contractor shall determine if the coating has cured sufficiently for proper application of succeeding coats. The maximum time between coats shall be in accordance with the manufacturer's written recommendations. If the maximum time between coats is exceeded, all newly coated surfaces shall be completely blast-cleaned again to a near white finish (SSPC-SP10) and re-coated at no additional cost to the Contracting Agency.

Dry film thickness measurements will be made in accordance with Section 6-07.3(5).

Temporary attachments or supports for scaffolding or forms shall not damage the coating system. All paint damage that occurs shall be repaired in accordance with the manufacturer's written recommendations and as follows. On bare areas or areas of insufficient primer thickness, the repair shall include the application of the field applied organic zinc primer system, and the final two coats of the Method A or Method B paint system. On areas where the primer is at least equal to the minimum required dry film thickness, the repair shall include the application of the final two coats of the Method A or Method B paint system. If any abrasive blast cleaning is required in the field it shall be done using an abrasive conforming to Section 6-07.2.

6-07.3(2) Repainting Existing Steel Structures

Unless otherwise provided, maintenance painting includes cleaning and painting all metal surfaces of an existing bridge. These include all metal surfaces that do not touch other metal, wooden floor or truss members, concrete or stone masonry, or other surfaces. Cleaning means removing rust, scale, unsound paint, dirt, grease, and other foreign matter. The Contractor shall clean and paint all exposed metal surfaces that may rust.

The Contractor shall abrasive blast all rust spots in accordance with the SSPC-SP6 Specifications for commercial blast cleaning. The edges of cleaned areas shall show no red or yellow rust. The edges of sound paint shall be feathered smooth. After abrasive blasting, the Contractor shall remove all loose rust, dirt, sand, and dust before painting.

6-07.3(2)A Bridge Cleaning

Bird Guano

Bird guano shall be completely removed prior to any other cleaning. All workers involved with bird guano removal operations shall be protected from absorption, inhalation, or ingestion of bird guano particles by wearing protective clothing as specified in the Contractor's Lead Health Protection Program (LHPP). Bird guano shall be removed in the dry to the extent possible. Following dry removal, the Contractor shall apply a 5.25% sodium hypochlorite solution to the remaining bird guano , followed by hand scrubbing, and pressure flushing as specified. The sodium hypochlorite solution shall not be used as an additive to the water used for pressure flushing, but shall be directly applied onto the areas of remaining bird guano. The bird guano shall be collected in a containment system approved by the Engineer and shall not enter any waterway or the surrounding environment. All bird guano shall be removed and disposed of at a land disposal site approved by the Engineer. The Contractor shall provide the Engineer with one copy of the disposal receipt, which shall include a description of the disposed material.

Fungicide Treatment

The Contractor shall treat all areas of fungus growth. When treating areas of fungus growth the Contractor shall use special cleaning methods before beginning general surface cleaning operations. The Contractor shall apply a 5.25% sodium hypochlorite solution to the bridge in fungus infested areas for a period recommended by the solution manufacturer or as specified by the Engineer. The sodium hypochlorite solution shall not be used as an additive to the water used for pressure flushing, but shall be directly applied onto the areas of fungus growth.

General Cleaning and Surface Preparation

Following fungicide treatment and removal of the bird guano, all steel surfaces to be painted shall be cleaned by either pressure flushing or sweep blasting. The cleaning process shall remove dirt, loose paint, and other material from the steel surfaces to be painted, but shall not remove well bonded paint. The Contractor shall follow the construction requirements of the cleaning method selected.

Spot abrasive blasting of all rusted steel surfaces and unbonded paint shall follow the pressure flushing or sweep blasting in areas designated by the Engineer. The Contractor shall hand clean, to the satisfaction of the Engineer, all surfaces inaccessible to cleaning with pressure flushing and sweep blasting equipment.

Prior to the application of paint the Contractor shall clean the bridge deck surface for the purpose of dust control.

Pressure Flushing

When pressure flushing is used, it shall be done with clean, fresh water only. No detergents, bleach, or other cleaning agents shall be employed. The pressure flushing equipment shall produce (at the nozzle) at least 20 megapascals with a discharge of at least 0.25 liters per second. The nozzle shall have a 25 degree tip and shall be held no more than 230 millimeters from the surface being washed. The use of a rotating tip nozzle may be allowed provided:

1. The Contractor requests its use in writing.
2. The pressure equipment shall produce at least 24 megapascals at the nozzle with a discharge of at least 0.25 liters per second.
3. There shall be no additional cost to the Contracting Agency.
4. The use of the nozzle has been approved in writing by the Engineer.

The Contractor may pressure flush other portions of the bridge for safety purposes, at no additional expense to the Contracting Agency.

All wash water and debris from pressure flushing shall be filtered through a filter fabric capable of collecting all loose debris and particles. A polypropylene, non-woven, needle-punched geotextile or equivalent shall be used as the filter fabric. The fabric shall have the following properties:

Grab tensile (ASTM D4632):	45 Kg Min.
Apparent opening size (ASTM D4751):	0.43mm (#40 US Sieve)
Permittivity (ASTM D4491):	0.7 sec - 1 or better

The fabric shall be supported underneath the structure to hold the contained material and shall be cleaned at intervals frequent enough to prevent clogging, overflow, or collapse. The debris obtained from the pressure water flushing operation shall be collected and tested in accordance with Section 6-07.3(2)C, and disposed off site at a waste disposal facility approved by the Engineer.

Sweep Blasting and Spot Abrasive Blasting

Sweep or spot abrasive blasting shall not begin until the containment system specified in Section 6-07.3(2)B is in place. No sweep or spot abrasive blasting shall begin until the surfaces are thoroughly dry. The abrasives to be used shall conform to Section 6-07.2**.** Sweep and spot abrasive blasting shall be done in such a manner that adjacent areas of work that have been partially or entirely completed are protected from damage.

Sweep blasting shall comply with the SSPC-SP7 requirements. Spot abrasive blasting shall comply with the SSPC-SP6 requirements.

The abrasive blasters shall be equipped with automatic shutoffs that operate by releasing the trigger mechanism. All abrasive blasting shall be directed towards the bridge center and away from the outboard sides, to facilitate catching all the containment waste. After abrasive blasting, all rust debris, dirt, abrasive and paint residue, and dust shall be completely removed before paint is applied.

6.07.3(2)B Containment of Abrasive Blasting

The Contractor shall protect the surrounding environment from all debris or damage resulting from the Contractor's operation. The Contractor shall take all measures necessary to contain and recover debris generated during cleaning, preparation, and coating operations. The Contractor shall design, construct, and maintain containment systems for abrasive blasting operations in accordance with best management practices. Disposal of the collected materials shall be as specified in the Section 6-07.3(2)C.

1. At the pre-construction conference, the Contractor shall submit a written Containment System Plan, including working drawings as appropriate, describing the methods for waste containment, collection, and disposal, to the Engineer for approval. The Contractor shall prepare and submit the Containment System Plan in accordance with Section 6-01.9. The Contractor shall not begin any abrasive blasting operations until receiving the Engineer's approval of the Containment System Plan.
2. The containment system shall not cause any damage to the existing structure.
3. The Contractor shall enclose all portions of the bridge to be blasted by sweep blasting or spot abrasive blasting as specified. The enclosed area shall consist of that portion below the area to be blasted, and extending up the sides of the structure to above the top of the structure. The enclosed length of each bridge span (defined as pier to pier) shall not exceed one half the length of the span. The containment system may remain open at the top.
4. The containment system shall be capable of being removed rapidly in case of high winds. Abrasive blasting operations shall cease if wind conditions prevent capture of blast rebound and paint residue by the containment system. If there is a question on wind conditions, the Engineer will make the final determination on whether blasting operations shall cease and the containment system removed.
5. The containment system shall not endanger the safety and health of the workers. Access to the containment system shall be designed to prevent any confined materials from escaping.
6. To prevent the weight of the confined materials from causing failure to the containment system, all confined materials shall be collected and secured in sealed containers at the end of each shift daily, at a minimum. No confined materials shall escape during transfer from the containment systems to the sealable containers. All confined materials within the containment system shall be removed and secured in sealable containers prior to relocation or removal of the containment system.
7. If failure to the containment system occurs or if signs of failure to the containment system are present, the Contractor shall stop work immediately. Work shall not resume until the failure has been corrected to the satisfaction of the Engineer.
8. The containment structure shall not be removed and painting operations shall not commence until all abrasive blasted surfaces have been inspected and approved for painting by the Engineer.
9. If the containment structure is removed after the abrasive blasting operation and before the coating operation, the Contractor shall install a drip tarp to prevent spillage of paint onto the waterway and ground surface below.

6-07.3(2)C Testing and Disposal of Containment Waste

After all waste from the containment structures has been collected, the Contractor shall have a minimum of three samples of the wastes tested by an accredited analytical laboratory. Each sample shall be taken from a different storage container unless directed otherwise by the Engineer.

The waste shall be tested for metals using the Toxicity Characteristics Leaching Procedure (TCLP), EPA Methods 1311 and 6010. At a minimum, the materials to be analyzed shall include Arsenic, Barium, Cadmium, Chromium Coppers, Lead, Mercury, Nickel, Selenium, Silver and Zinc.

If the average of the tested samples is at or above all threshold limits as stated in the Dangerous Waste Regulation, Chapter 173-303 WAC, the containment waste will be designated as "Dangerous Waste" and shall be disposed of at a permitted hazardous waste repository. If the average of the tested samples is below the threshold limits, the containment waste will be designated as "Solid Waste" and shall be disposed at a permitted sanitary landfill that will accepts the waste. Disposal shall be in accordance with Chapter 173-303 WAC for waste designated "Dangerous Waste" or "Extremely Hazardous Waste" and in accordance with Chapter 173-304 WAC for waste designated as "Solid Waste".

The Contractor shall supply (2) two copies of the transmittal documents or bill of lading listing the waste material shipped from the construction site to the waste disposal site. One copy of the shipment list shall show the signature of the Engineer and shall have the waste site operator's confirmation for receipt of the waste.

In the event that the containment wastes are designated as "Dangerous Wastes" or "Extremely Hazardous Waste" under Chapter 173-303 WAC, the Contracting Agency will provide to the Contractor the appropriate EPA identification number.

Unless noted otherwise a waste site will not be provided by the Contracting Agency for the disposal of waste materials and debris.

6-07.3(2)D Drip Tarps

During painting operations the Contractor shall furnish, install, and maintain drip tarps below the areas to be painted to contain all spilled paint, buckets, brushes, and other deleterious material, and prevent such materials from reaching the environment below the bridge. Drip tarps shall be absorbent material and hung to minimize puddling.

The Contractor shall submit to the Engineer for approval, a proposed method for hanging the drip tarps below the paint platforms and connecting them to the bridge, in accordance with Section 6-01.9. After the Contractor has completed painting of the structure, the drip tarps and all connecting hardware shall be removed from the project.

At the pre-construction conference, the Contractor shall submit to the Engineer for approval, a written detailed method for the removal of any accidental spills or drips on traffic which occur during the normal painting operations. A vehicle cleaning station shall be provided.

At the pre-construction conference, the Contractor shall designate, in writing, a supervisory employee of the Contractor who will be on the project at all times and will be fully responsible for taking the required corrective action should any paint damage occur.

6-07.3(2)E Sampling and Testing

The Contractor shall provide the Engineer the following materials and information for testing:

1. One liter of each coating material and of each thinner for testing of each batch or lot that is sampled at the factory at the time of containerizing. The Contracting Agency may, at its discretion, place an Inspector at the site of manufacture.
2. A manufacturer's certificate certifying the test results for each batch of each coat. In addition, if the coating is specified for use on a steel contact surface, the certificate shall certify that the coating material meets the requirements for coefficient of friction.
3. A Product Data Sheet for each coating material and thinner.
4. A Material Safety Data Sheet with the initial sample for each type of coating material and thinner.

5. If the quantity of paint required for each component of the coating system is 75 liters or less, Item 1 will not apply, and the coating system components will be accepted based on the manufacturer's notarized statement as specified in Section 9-08.3 along with copies of Items 2, 3, and 4.

The following tests will be used to insure that the coating materials meet the requirements of the specifications.

Test	Test Method
Weight-Per-Gallon Determination of Paints and Coatings	ASTM D 1475
Determination of Zinc Dry Films of Paints and Coatings	ASTM D 2371
Coarse Particles in Pigments, Pastes, and Paints	ASTM D 185
Consistency of Paints Using the Stormer Viscometer	ASTM D 562
Finess of Dispersion of Pigment-Vehicle Systems	ASTM D 1210
Drying, Curing, of Film Formation of Organic Coatings at Room Temperatures	ASTM D 1640
Volatile Content of Paints	ASTM D 2369
Pigment Content of Solvent-Type Paints	ASTM D 2371
Infrared Identification of Vehicle Solids From Solvent-Type Paints	ASTM D 2621
Volume Nonvolatile Matter in Clear or Pigmented Coatings	ASTM D 2697
Vehicle Solids (Ordinary Centrifuge)	FTMS 141 Method 4051
Nonvolatile Vehicle Content	FTMS 141 Method 4053

Sampling and testing performed by the Contracting Agency shall not be construed as determining or predicting the performance or compatibility of the individual coating material, or the completed coating system.

The Contractor shall furnish to the Engineer 19 liters of finish coat paint in the appropriate color specified in the Special Provisions as a part of this contract. The paint container shall be marked to show the lot number, bridge number and paint name and color number.

6-07.3(2)F Preparing Paint Materials for Use

Coating materials will be rejected if:

a) The material arrives at the application site in other than the original, unopened containers.
b) The container has a break in the lid seal or a puncture.
c) The coating material has begun to polymerize, solidify, gel, or deteriorate in any manner.
d) The recommended shelf life, as stated on the manufacturer's product data sheets, has expired.

e) A skin forms on the surface of the material or on the sides of the container and the volume of the skin exceeds 2 percent of the material. If there is not more than 2 percent skin, the Contractor shall remove and discard only the skin.

Mixing

The Contractor shall thoroughly mix coating materials by mechanical means to ensure a uniform composition. Coating materials shall not be mixed by means of air stream bubbling or boxing. Coating materials shall be mixed in the original containers and mixing shall continue until all pigment or metallic powder is in suspension. Care shall be taken to ensure that the solid coating material that has settled to the bottom of the container is thoroughly dispersed. After mixing, the Contractor shall inspect the coating materials for uniformity and to ensure that no unmixed pigment or lumps are present.

Catalysts, curing agents, hardeners, initiators, or dry metallic powders which are packaged separately shall be added to the base coating material only after the base coating material is thoroughly mixed to achieve a uniform mixture with all particles wetted. The Contractor shall then add the proper volume of curing agent to the correct volume of base and mix thoroughly. The mixture shall be used within the pot life specified by the manufacturer. Unused portions shall be discarded at the end of each work day.

Thinning

The Contractor shall not add additional thinner at the application site except as approved by the Engineer. The amount and type of thinner, if allowed, shall conform to the manufacturer's specifications.

Application Site Tinting

Application site tinting will not be allowed except as approved by the Engineer.

Agitators

When recommended by the manufacturer, the Contractor shall constantly agitate coating materials during application by use of paint pots equipped with mechanical agitators.

6-07.3(2)G Painting Steel Surfaces

The coating system for all steel surfaces shall incorporate three single component moisture-cured polyurethane coats. The first component shall be the primer coat, Standard Formula A-11-99. This coat shall be used as a spot coat in areas that are cleaned down to bare metal. The second coat shall be Standard Formula B-11-99 and third coat shall be Standard Formula C-11-99. The second and third coats shall encapsulate the entire structures.

In addition to the requirements of the Specifications, coating applications shall conform to:

a) The best practices of the trade.
b) The written recommendations of the coating manufacturer.
c) All applicable portions of the SSPC-PA1.

No primer paint shall be applied to any surface until the surface has been inspected and approved by the Engineer. Any area to which primer paint has been applied without the Engineer's inspection and approval will be considered improperly cleaned. The unauthorized application shall be completely removed and the entire area recleaned to the satisfaction of the Engineer. After the area has been recleaned, inspected, and approved, the Contractor may again initiate the painting sequence.

No additional compensation or extension of time in accordance with Section 1-08.8 will be allowed for the removal of any unauthorized paint application and recleaning of the underlying surface.

Surface Condition

The surface to be covered with a coating shall be free of dust, grease, or other substance which would prevent the bond of the succeeding application. The Contractor shall protect freshly coated surfaces from contamination by abrasives, dust, or foreign materials from any other source. The Contractor shall prepare contaminated surfaces to the satisfaction of the Engineer before applying another coat.

Application Methods

The Contractor shall apply coating materials by air or airless spray, brush, roller, any combination of these methods, or as recommended by the coating material manufacturer, unless otherwise specified. All application techniques shall conform to Section 7, SSPC-PA 1.

Each coat shall be applied in a uniform layer, completely covering the preceding coat. Individual coats shall be tinted a sufficiently different shade so that each coat can be easily detected. The Contractor shall correct runs, sags, skips, or other deficiencies before application of succeeding coats. Such corrective work may require recleaning, application of additional coating, or other means as determined by the Engineer at no additional cost to the Contracting Agency.

Painters, using brushes, shall work from pails containing a maximum of 7.5 liters of paint. This is intended to minimize the impact of any spill.

Paint shall be stored and mixed in a secure, contained location to eliminate the potential for spills into State waters and unto the ground and highway surfaces.

Environmental Conditions

Apply coating materials only during periods when:

1. Air temperature is above 2C.
2. Steel surface temperature is between 2C and 46C.
3. Steel surface does not show wet drops and is not wet.
4. Relative humidity is within the manufacturer's recommended range.

Application will not be allowed if the Engineer determines that conditions are not favorable for proper application and performance of the coating.

During painting operations the area below the bridge shall be protected with a drip tarp as specified in Section 6-07.3(2)D.

If fresh coatings are damaged by the elements, the Contractor shall replace or repair the coating to the satisfaction of the Engineer at no additional cost to the Contracting Agency

Cleaning of equipment shall not be done in State waters nor shall resultant cleaning runoff be allowed to enter State waters. No paint cans, lids, brushes, or other debris shall be allowed to enter State waters.

Solvents, paints, paint sludge, cans, buckets, rags, brushes, and other waste associated with this project shall be collected and disposed of off site.

Paint products, petroleum products or other deleterious material shall not be wasted into, or otherwise enter, State waters as a result of project activities.

Application of Coatings

After applying the spot prime coat to all areas cleaned to bare metal and before applying the intermediate coat, the Contractor shall apply a stripe coat on all edges, corners, seams, crevices, interior angles, junction of joint members, rivet or bolt heads, nuts and

threads, weld lines, and any similar surface irregularities. The stripe coat shall be the same formula as the intermediate coat. The stripe coat shall be of sufficient thickness to completely hide the surface being covered and shall be followed as soon as practical by the application of intermediate coat to its specified thickness. All stripe coats shall be done by brush

If the spot prime coat leaves unsealed cracks or crevices, these shall be sealed with single component urethane sealant meeting the requirements of Federal specification TT-S-00230C, Type II, Class A (applied per the manufacturer's recommendation) before the intermediate coat is applied.

Coating thickness measurements will be made by the Engineer after the application of each coat and before the application of the succeeding coat. In addition, the Engineer will inspect for uniform and complete coverage and appearance. One hundred percent of all thickness measurements shall be the minimum wet film thickness specified in Section 6-07.3(5). If thickness measurements or visual inspection of coverage do not meet the specified minimum, the Contractor shall make additional applications, as necessary, to achieve thickness and coverage requirements.

In areas where wet film thickness measurements are impractical, dry film thickness measurements will be made using magnetic dry film thickness gauges as specified in Section 6-05.3(5).

If a question arises about an individual coat thickness or coverage, it will be verified by the use of a Tooke gage. If the Tooke gage shows a coat thickness to be less than a minimum dry film thickness of 0.038mm or indicates a missing intermediate coat, the total coating system will be rejected, even if the thickness of the total system equals or exceeds the total thickness specified.

If roadway or sidewalk planks lie so close to the metal that they prevent proper cleaning and painting, the Contractor shall remove or cut the planks to provide at least a 25 mm clearance. Any plank removal or cutting shall be done as the Engineer directs. The Contractor shall replace all planks after painting. If removal breaks or damages the planks and makes them unfit for reuse, the Contractor shall replace them at no expense to the Contracting Agency.

6-07.3(3) Painting Timber Structures

6-07.3(3)A Number of Coats and Color

Unless the Plans state otherwise:

1. Rails and rail posts on timber bridges shall receive two coats (with the wheel guard painted only on its top edge and roadway side).
2. Other timber work shall receive three coats (if the Plans or Special Provisions require it to be painted).

Paint color shall be as the Plans, Special Provisions, or Engineer may require.

6-07.3(3)B Application

As it is painted, any wood surface must be thoroughly dry and free from oil and dirt. Paint shall be applied by brush, spread evenly, and worked thoroughly into all seasoning cracks, corners, and recesses. No later coat shall be applied until the full thickness of the previous coat has dried.

Final brush strokes with aluminum paint shall be made in the same direction to ensure that powder particles "leaf" evenly.

If a painted surface has been stained by creosote nearby, it shall be given one or more coats of an approved shellac before repainting.

6-07.3(3)C Painting Treated Timber

Timber treated with creosote or oil-borne, pentachlorophenol preservatives shall normally not be painted.

Timber treated with water-borne preservatives shall be clean and be reduced to no more than 18 percent moisture content before it is painted. Any visible salt crystals on the wood surface shall be washed and brushed away — with the moisture content reduced again to the specified level before painting. Stored timber awaiting painting shall be covered and stacked with spreaders to ensure air circulation.

6-07.3(4) Painting Galvanized Surfaces

Before galvanized surfaces are painted, they shall be cleaned per the requirements of SSPC-SP 1. Either the solvent or the steam cleaning alternatives of SSPC-SP 1 shall be used. The alkali alternative shall not be used.

The Contractor shall paint the dry surface as follows:

	Paint Formulas	Type
First Coat	MIL-P-24441	Epoxy polyamide
Second Coat	C-11-99	Moisture Cured Aliphatic Polyurethane

Each coat shall be dry before the next coat is applied. All coats applied in the shop shall be dried hard before shipment.

6-07.3(5) Paint Film Thickness

The paint film thickness for the paint system of Section 6-07.3(1) shall be as follows. The dry film thickness of the primer coat on the faying surfaces and on the top flanges where the welded shear connectors have been attached shall not be less than 65 micrometers nor greater than 90 micrometers. On all other areas, the minimum dry film thickness for the primer coat shall be 65 micrometers. The minimum dry film thickness for the intermediate coat shall be 90 micrometers. The minimum dry film thickness for the top coat shall be 25 micrometers.

The paint film thickness for the paint system of Section 6-07.3(2) shall be as follows. The minimum wet film thickness of each coat (primer, intermediate, and finish) shall be 150 micrometers.

If Formula A-5-61 is used, the dry film thickness shall be between 10 and 18 micrometers. (The rapid solvent release in this vinyl pretreatment makes it difficult to measure wet film thickness.)

Any other finish, no matter how applied, shall have a wet thickness of at least 150 micrometers per coat and a dry film thickness of at least 75 micrometers per coat.

If the specified number of coats do not produce a combined dry film thickness of at least the sum of the thicknesses required per coat, the Contractor shall apply another full coat of finish paint.

Film thickness — wet and dry — will be measured by suitable gauges. The dry film thickness will be determined by the use of a magnetic or magnetic flux dry film thickness gauge. The gauge shall be calibrated on the blasted steel with plastic shims the same thickness as the minimum dry film thickness. Wet measurements will be taken immediately after the paint is applied, and dry measurements after the coat is dry and hard.

6-07.3(6) Protection of Public and Private Property

The Contractor shall protect public and private property, traffic, and other parts of the bridge (deck, sidewalks, etc.) from airborne or dripping paint. The Contractor shall supply and install enough canvas or other covering to provide this protection as painting proceeds. If the covering does not adequately protect traffic, the Engineer may require the Contractor to station lookouts who shall stop the painting while vehicles or pedestrians pass.

6-07.4 Measurement

No specific unit of measurement will apply to the lump sum price for cleaning and painting existing steel structures.

6-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for each the following bid items that are included in the proposal:

"Cleaning and Painting - _____", lump sum.

The lump sum contract price for "Cleaning and Painting - _____" shall be full pay for all cost in connection with furnishing and placing all necessary staging and rigging, providing material, labor, tools, and equipment, performing all cleaning and preparation of surfaces to be painted and applying all coats of paint and sealant.

"Containment of Abrasives", lump sum.

The lump sum contract price for "Containment of Abrasives" shall be full payment for all costs incurred by the Contractor in complying with the requirements as specified for containment of abrasives.

"Testing and Disposal of Containment Waste", by force account as provided in Section 1-09.6.

For the purpose of providing a common proposal for all bidders the Contracting Agency has entered an amount for the item "Testing and Disposal of Containment Waste" in the bid proposal to become a part of the total bid by the Contractor.

Payment for painting new steel structures and timber structures will be in accordance with Sections 6-03.5, and 6-04.5, respectively.

6-08 WATERPROOFING

6-08.1 Description

This work shall consist of applying waterproofing materials to Portland cement concrete surfaces as required by the Plans, these Specifications, or the Engineer.

The application of these waterproofing materials will not be required if a concrete admixture meeting the requirements of 9-23.8 is used.

6-08.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt for Waterproofing	9-11.1
Waterproofing Fabric	9-11.2
Portland Cement Mortar	9-11.3
Waterproofing Admixture	9-23.8

6-08.3 Construction Requirements

6-08.3(1) Storage of Fabric

The fabric shall be stored in a dry, protected place. Rolls shall not be stored standing on end.

6-08.3(2) Preparation of Surface

Concrete surfaces shall be reasonably smooth and without projections or holes that might puncture the waterproofing membrane. The surfaces shall be dry, with all dust and loose material removed. The Contractor shall not apply waterproofing in wet weather or when the air temperature is below 2°C unless the Engineer approves in writing.

6-08.3(3) Application of Waterproofing

Waterproofing asphalt shall be stirred frequently as it is heated to between 150°C and 180°C. Each heating kettle shall have a thermometer.

Each coat of primer or asphalt shall begin at the low point of the surface so that water will run over (not against or along) the laps.

In applying the waterproofing, the Contractor shall:

1. Apply a coat of primer and let it dry before applying the first asphalt coat.
2. Mop hot asphalt on a band about 510 millimeters wide across the full length of the surface.
3. Immediately roll a starter strip of half-width fabric into the asphalt, pressing it into place to rid it of all air bubbles and to conform it closely to the surface.
4. Mop hot asphalt over the starter strip and an adjacent section of surface so that the fresh asphalt forms a band slightly wider than the full width of the fabric.
5. Immediately roll a full-width strip of fabric into the fresh asphalt, pressing it into place as before.
6. Mop hot asphalt on the latest strip and on an adjacent band of the surface slightly wider that the full width of the fabric.
7. Immediately roll another strip of fabric into the asphalt, lapping the earlier strip by at least 50 millimeters and pressing it into place as before.
8. Repeat steps 6 and 7 until the entire surface is covered.
9. Mop the entire surface with a final coating of hot asphalt.

The three complete moppings of asphalt shall ensure that no fabric layer ever touches another fabric layer or the concrete surface. The Contractor shall examine all laps and ensure that they are thoroughly sealed down.

Each mopping shall cover completely, with a coat heavy enough to hide the fabric weave and all gray spots from the concrete. On horizontal surfaces, at least 48 liters of asphalt shall be used for every 10 square meters of finished work. On vertical surfaces, at least 6 liters per 10 square meters shall be used.

At the end of each day's work, all fabric that was laid shall have received its final mopping of asphalt.

Wherever the membrane ends or is punctured by drains, pipes, etc., the Contractor shall seal the area to prevent water from entering between the waterproofing and the concrete surface.

All flashing (at curbs, against girders, spandrel walls, etc.) shall be made of separate sheets that lap the main membrane by at least 300 millimeters. Flashing shall be sealed closely: (1) with full metal flashing, or (2) by imbedding its upper edges in a groove poured full of an acceptable joint cement.

At each expansion joint, the membrane shall not be broken but shall be folded to permit movement. At either end of the bridge, the membrane shall run well down abutments and shall allow for expansion and contraction.

6-08.3(4) Protection Course

If the Plans require, the Contractor shall place a layer of mortar at least 38 millimeters thick over the whole surface of the membrane just after it has cooled to air temperature. This layer shall be a mix of one part Portland cement to two parts sand. It shall be distributed evenly over the membrane, tamped gently into place, finished by hand to a smooth, hard surface, then covered and kept moist for one week.

6-08.4 Measurement

Measurement will be the number of square meters of the surface of the waterproofed area.

6-08.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Waterproofing", per square meter.

Waterproofing of construction joints not shown in the Plans shall be at the Contractor's expense.

6-09 CRIBBING

6-09.1 Description

This work is providing materials and constructing cribbing as required by the Plans, these Specifications, and the Engineer.

6-09.2 Materials

Materials shall meet the requirements of the following sections:

Metal Cribbing	9-27.1
Gabion Cribbing	9-27.3
Wire	9-27.3(1)
Clip Fasteners	9-27.3(2)
Stone	9-27.3(3)

6-09.3 Construction Requirements

6-09.3(1) General Requirements

6-09.3(1)A Foundations

Before placing any crib work, the Contractor shall excavate the foundation or bed to the specified grade and obtain the Engineer's approval on bearing quality.

6-09.3(2) Vacant

6-09.3(3) Vacant

6-09.3(4) Vacant

6-09.3(5) Vacant

6-09.3(6) Gabion Cribbing

6-09.3(6)A Description

This work is building wire gabion cribbing as required by the Plans, these Specifications, and the Engineer.

6-09.3(6)B Baskets

Baskets may be fabricated from either woven or welded steel wire; however, a gabion structure shall not include both. Baskets may be assembled with either lacing wire or clip fasteners; however, a perimeter or diaphragm edge shall not include both.

6-09.3(6)C Dimensions

The Contractor shall supply gabion baskets in the lengths and heights the Plans require. Each length shall be a multiple (double, triple, or greater) of horizontal width. Horizontal width shall be 0.9 meter. All baskets from the same manufacturer shall be the same width and shall be within a tolerance of 5 percent of the manufacturer's stated sizes.

6-09.3(6)D Fabrication of Baskets

Gabions shall be made so that the sides, ends, lid, and diaphragms can be assembled into rectangular baskets of the required sizes at the construction site. Common-wall construction may be used in gabion structures up to 3 meters high. Common-wall construction

includes any basket where its top serves as the bottom of the one above it or where one wall serves an adjacent basket. When gabion structures are more than 3 meters high, the baskets shall have independent sides, ends, top, and bottom.

Each gabion shall be divided by diaphragms into cells the same length as horizontal basket width. Diaphragms shall be made of the same mesh and gage as the basket body.

All perimeter and diaphragm edges shall be laced or clipped together so that joints are at least as strong as the body of the mesh itself. The ends of the lacing wire shall be anchored by three tight turns around the selvage wire.

6-09.3(6)E Filling Baskets

Baskets shall be filled with stone that meets the requirements of Section 9-27.3(6). The stone shall be placed and compacted to meet the unit mass requirements of Section 6-09.3(6)F.

Filling shall be in compacted layers not more than 350 millimeters deep. If cross-connecting wires are required, the Contractor shall adjust the number and depth of layers so that wires occur between the compacted layers.

6-09.3(6)F Unit Mass Requirements and Test

The unit mass of the filled gabion basket shall be at least 1600 kilograms per cubic meter. Should the unit mass be less than 1600 kilograms per cubic meter, the gabion will be rejected and the Engineer will require the Contractor to conduct and pass additional unit mass tests before completing other gabions.

The Contractor shall conduct either of the following unit mass tests to prove the density of completed gabions:

1. A filled gabion basket shall be selected from the completed structure and weighed.
2. A gabion basket shall be filled with stone from a loaded truck that has been weighed. After filling, the truck and unused stone shall be weighed again. The difference between the two weighings shall be used to determine mass per cubic meter of the material in the gabion.

The Contractor shall conduct one unit mass test for each 500 cubic meters of gabions placed. The Engineer may reduce the required frequency of these tests after proper unit mass has been consistently demonstrated.

In conducting unit mass test A or B, the Contractor shall provide and use scales that comply with Section 1-09.2.

6-09.3(6)G Construction Requirements

Each row or tier of baskets shall be reasonably straight and shall conform with alignment and grade. Hexagonal mesh baskets shall be stretched endwise before filling. Filler shall be placed carefully, then tamped or vibrated. The last layer shall fill each basket completely so that the secured lid will rest on the filler. Each basket shall be laced securely to all adjacent baskets and its lid then laced or clipped to the sides, ends, and diaphragms.

All selvage wires of ends of adjacent baskets shall be laced together. The bottom selvage of the basket being constructed on a previously constructed basket must be laced to the top of that basket.

Excavation for gabions shall comply with the requirements for structure excavation, Class B, in Section 2-09.

Backfilling behind or around gabions shall comply with Section 2-09.3(1)E.

6-09.4 Measurement

Gabion cribbing will be the calculated neat line volume of gabion baskets in place, using the manufacturer's stated dimensions.

Structure excavation Class B and structure excavation Class B including haul will be measured by the cubic meter as specified in Section 2-09.

6-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Structure Excavation Class B", per cubic meter.

"Structure Excavation Class B Incl. Haul", per cubic meter.

"Gabion Cribbing", per cubic meter.

6-10 CONCRETE BARRIER

6-10.1 Description

This Section applies to building precast or cast-in-place cement concrete barriers as required by the Plans, these Specifications, or the Engineer.

6-10.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Fillers	9-04.1
Reinforcing Steel	9-07

Wire rope shall be Class 6 x 19, made of improved plow steel that has been galvanized and preformed. Galvanizing shall meet ASTM A 603. The wire rope shall have right regular lay and a fiber core. It shall be 16 millimeters in diameter and have a minimum breaking strength of 130 kiloNewtons.

All hardware (connecting pins, drift pins, nuts, washers, etc.) shall be galvanized in keeping with AASHTO M 232.

Connecting pins shall comply with ASTM A 449 and, after galvanizing checked for embrittlement by ASTM A 143. All other hardware shall comply with ASTM A 307.

Grout for permanent installations of precast single slope barrier shall be in accordance with Section 6-02.3(20).

6-10.3 Construction Requirements

Single slope barrier shall be cast-in-place or slipformed, except when precast single slope barrier is specified in the Plans or approved by the Engineer.

6-10.3(1) Precast Concrete Barrier

The concrete in precast barrier shall be Class 28 and comply with the provisions of Section 6-02.3. No concrete barrier shall be shipped until test cylinders made of the same concrete and cured under the same conditions show the concrete has reached 28 Mpa.

The Contractor may use Type III Portland cement, but shall bear any added cost.

Precast barrier shall be cast in steel forms. After release, the barrier shall be finished to an even, smooth, dense surface, free from any rock pockets or holes larger than 6 millimeters across. Trowelling shall remove all projecting concrete from the bearing surface.

Precast concrete barrier shall be cured in accordance with Section 6-02.3(25)D except that the barrier shall be cured in the forms until a rebound number test, or test cylinders which have been cured under the same conditions as the barrier, indicate the conrete has reached a compressive strength of a least 17.2 megapascals. No additional curing is required once the barrier is removed from the forms.

The barrier shall be precast in sections as the Standard Plans require. All barrier in the same project (except end sections and variable length units needed for closure) shall be the same length. All barrier shall be new and unused. It shall be true to plan dimensions. The manufacturer shall be responsible for any damage or distortion that results from manufacturing.

Only one section less than 3 meters long may be used in any single run of precast barrier, and it must be at least 2.4 meters long. It may be precast or cast-in-place. Hardware identical to that used with other sections shall interlock such a section with adjacent precast sections.

Barrier connection voids for permanent installations of precast single slope barrier shall be filled with grout.

6-10.3(2) Cast-In-Place Concrete Barrier

Forms for cast-in-place barrier shall be made of steel or of exterior plywood coated with plastic. At the Contractor's option, the barrier may be constructed by the slip-form method.

The barrier shall be made of Class 28 concrete that meets the requirements of Section 6-02. The Contractor may use Portland cement Type III, but shall bear any added cost.

Immediately after removing the forms, the Contractor shall complete any finishing work needed to produce a uniformly smooth, dense surface. The surface shall have no rock pockets and no holes larger than 6 millimeters across. The barrier shall be cured in accordance with the requirements described in Section 6-02.3(11)A.

The maximum allowable deviation from a 3-meter straightedge held longitudinally on all surfaces shall be 6 millimeters.

The Contractor may build cast-in-place concrete barrier by the slip-form method. Concrete for slip-form barrier shall meet the requirements for concrete Class 28 as outlined in Section 6-02.3, except that the fine aggregate gradation may be Class 1 or 2. Slip-form barrier shall be finished and cured in the same manner as required for concrete traffic and pedestrian barrier in Section 6-02.3(11)A.

At final acceptance of the project, the barrier shall be free from stains, smears, and any discoloration.

6-10.3(3) Resetting Concrete Barrier

The Contractor shall reset concrete barrier if the Plans or the Engineer require. If resetting is impossible immediately after removal, the Contractor shall store the barrier at Engineer-approved locations.

6-10.3(4) Joining Precast Concrete Barrier to Cast-In-Place Barrier

The Contractor may join segments of cast-in-place barrier to precast barrier where transitions, split barriers, or gaps shorter than 3 meters require it. At each joint of this type, the cast-in-place segment shall include hardware that ties both its ends to abutting precast sections.

6-10.3(5) Temporary Concrete Barrier

For temporary concrete barrier, the Contractor may use new or used precast barrier. This barrier shall comply with Standard Plan requirements and cross-sectional dimensions, except that: (1) it may be made in other lengths than those shown in the Standard Plan, and (2) it may have permanent lifting holes no larger than 100 millimeters in diameter or lifting loops. The word "temporary" shall be visibly stamped or stencil painted on each barrier segment.

All barrier shall be in good condition, without cracks, chips, spalls, dirt, or traffic marks. If any barrier segment is damaged during or after placement, the Contractor, at no expense to the Contracting Agency, shall immediately repair it to the Engineer's satisfaction or replace it with an undamaged section.

As soon as the temporary barrier is no longer needed, the Contractor shall remove it from the project. Contracting Agency furnished barrier shall remain Contracting Agency property, and the Contractor shall deliver it wherever the Engineer directs. Contractor furnished barrier shall remain the property of the Contractor.

6-10.3(6) Placing Concrete Barrier

Precast concrete barrier shall rest on a paved foundation shaped to a uniform grade and section. The foundation surface shall meet this test for uniformity: When a 3-meter straightedge is placed on the surface parallel to the centerline for the barrier, the surface shall not vary more than 6 millimeters from the lower edge of the straightedge. If deviations exceed 6 millimeters, the Contractor shall correct them as required in Section 5-04.3(13).

The Contractor shall align the joints of precast segments so that they offset no more than 6 millimeters transversely and no more than 19 millimeters vertically. Grouting is not permitted, except as previously stated for single slope barrier. If foundation grade and section are acceptable, the Engineer may permit the Contractor to obtain vertical alignment of the barrier by shimming. Shimming shall be done with a polystyrene, foam pad (300 by 600 millimeters) under the end 300 millimeters of bearing surface.

Precast barrier shall be handled and placed with equipment that will not damage or disfigure it.

6-10.3(7) Concrete Barrier Berm Type 1

The berm shall be constructed in accordance with the Plans.

The berm material shall be placed in lifts not to exceed 150 millimeters compacted depth after 2 passes with a mechanical tamper.

The berm shall be raked to a smooth uniform surface.

6-10.4 Measurement

Precast concrete barrier will be measured by the meter along its completed line and slope.

Temporary concrete barrier will be measured by the meter along the completed line and slope of the barrier, one time only for each setup of barrier protected area. Any intermediate moving or resetting will not be measured.

Cast-in-place concrete barrier will be measured by the meter along its completed line unless the contract specifies that it be measured per cubic meter for concrete Class 28 and per kilogram for steel reinforcing bar (as required in Section 6-02.4).

Cast-in-place concrete barrier light standard section will be measured by the unit for each light standard section installed.

Concrete barrier berms will be measured by the unit for each berm installed.

6-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Precast Conc. Barrier Type ____", per meter.

"Cast-In-Place Conc. Barrier", per meter.

"Conc. Class 28", per cubic meter.

"St. Reinf. Bar", per kilogram.

The unit contract price per meter for "Cast-In-Place Conc. Barrier" shall be full pay for excavation, forms, placement, special construction features, and all other materials, tools, equipment, and labor necessary to complete the work as specified; except that when

the contract specifies, the unit contract price per cubic meter for “Conc. Class 28” and the per kilogram for “St. Reinf. Bar” shall be full pay for excavation, forms, placement, special construction features, and all other materials, tools, equipment, and labor necessary to complete the work as specified.

“Single Slope Concrete Barrier”, per meter

The unit contract price per meter for “Single Slope Concrete Barrier” shall be full pay for either cast in place or precast single slope concrete barrier.

“Cast-In-Place Conc. Barrier Light Standard Section”, per each.

“Temporary Conc. Barrier”, per meter.

The unit contract price per meter for “Temporary Concrete Barrier” shall be full pay for all costs, including furnishing, installing, connecting, anchoring, maintaining, temporary storage, and final removal of the temporary barrier.

Payment for transition sections between different types of barrier shall be made at the unit contract price for the type of barrier indicated in the Plans for each transition section.

“Conc. Barrier Berm Type 1”, per each.

6-11 PRECAST CONCRETE RETAINING WALL STEMS

6-11.1 Description

The Contractor may construct Standard Plan Reinforced Concrete Retaining Walls Type 1, 2, 3, and 4 using precast concrete wall stems as specified herein.

6-11.1(1) Submittals

Before proceeding with construction of the retaining walls using precast concrete wall stems, the Contractor shall submit the following to the Engineer for approval in accordance with Section 6-02.3(16):

1. Working drawings for fabrication of the wall stems, showing dimensions, reinforcing steel, joint and joint filler details, lifting devices with the manufacturer's recommended safe working capacity, and material specifications.
2. Falsework plans for the erection of the wall stems showing dimensions, support points, support footing sizes, erection blockouts, member sizes, connections, and material specifications.
3. Calculations for the precast wall, the connection between the precast wall and the cast-in-place footing, and any modifications to the cast-in-place footing. Calculations shall be prepared by a professional civil engineer licensed in the state of Washington.

6-11.2 Materials

Concrete for the precast concrete wall stems shall meet all the requirements for concrete Class 28 as stated in Section 6-02.3.

Concrete for the cast-in-place footing shall meet all the requirements for concrete Class 28LS as stated in Section 6-02.3.

6-11.3 Construction Requirements

The precast concrete wall stems shall be fabricated in accordance with the dimensions and details shown in the Plans, except as modified in the approved working drawings.

The precast concrete wall stems may be fabricated full height in 2.4-meter, 4.88-meter, or 7.32-meter widths.

The precast concrete wall stems shall be constructed with a mating shear key between adjacent panels. The shear key shall have beveled corners and shall be 38 millimeters in thickness. The width of the shear key shall be 89 millimeters minimum and 140 millimeters maximum. The shear key shall be continuous and shall be of uniform width over the entire height of the wall stem.

Rolled on textured finishes shall not be used. Precast stem walls shall be cast in a vertical position if the Plans call for a form liner texture on both sides of the stem wall.

The precast wall panel shall be rigidly held in place during placement and curing of the footing concrete.

To ensure an even flow of concrete under and against the base of the wall, a form shall be placed parallel to the wall stem, above the footing, to allow a minimum 300-millimeter head to develop in the concrete during concrete placement.

The reinforcing steel shall be shifted to clear the erection blockouts in the wall stem by 38 millimeters minimum.

All panel joints shall be constructed with joint filler installed on the rear (backfill) side of the wall. The joint filler material shall extend from 0.6 meter below the final ground level in front of the wall to the top of the wall. The joint filler shall be a nonorganic flexible material and shall be installed to create a waterproof seal at panel joints.

The soil bearing pressure beneath the falsework supports for the wall stems shall not exceed the maximum design soil pressure shown in the Plans for the retaining wall.

The wall stem shall be placed a minimum of 25 millimeters into the footing to provide a shear key. The base of the stem shall be sloped 43 millimeters per meter to facilitate proper concrete placement.

6-11.3(1) Tolerances

The construction tolerances for the precast retaining wall stems shall be:

Height	±6 millimeters
Width	±6 millimeters
Thickness	+6 millimeters –3 millimeters
Conc. cover for steel reinforcing bar	–3 millimeters +10 millimeters
Width of panel joints	±6 millimeters
Offset of panels (deviation from a straight line extending 1.5 meters on each side of panel joint)	±6 millimeters

6-11.4 Measurement

Measurement of the materials involved in constructing the precast concrete retaining wall stems and cast-in-place footing will be in accordance with Section 6-02.4 for the applicable related bid items of work involved in constructing Standard Plan Reinforced Concrete Retaining Walls Type 1, 2, 3, and 4.

6-11.5 Payment

All costs associated with constructing the retaining walls using precast concrete retaining wall stems shall be included in the unit contract prices for the applicable related bid items of work required for construction of Standard Plan Reinforced Concrete Retaining Walls Type 1, 2, 3, and 4.

DIVISION 7
DRAINAGE STRUCTURES, STORM SEWERS, SANITARY SEWERS, WATER MAINS, AND CONDUITS

7-01 DRAINS

7-01.1 Description

This work shall consist of constructing drain pipe and underdrain pipe in accordance with the Plans, these Specifications and Standard Plans, at the locations staked.

7-01.2 Materials

Materials shall meet the requirements of the following sections:

Gravel Backfill for Drains	9-03.12(4)
Concrete Drain Pipe	9-05.1(1)
Zinc Coated (Galvanized) Corrugated Iron, Aluminum Coated (Aluminized) Corrugated Iron, Zinc Coated (Galvanized) Steel, Aluminum Coated (Aluminized) Steel Drain Pipe	9-05.1(2)
Corrugated Aluminum Alloy Drain Pipe	9-05.1(3)
Polyvinyl Chloride (PVC) Drain Pipe, 200-millimeter diameter maximum	9-05.1(5)
Corrugated Polyethylene (PE) Drain Pipe, 200-millimeter diameter maximum	9-05.1(6)
Corrugated Polyethylene (PE) Drain Pipe, 300-millimeter through 600-millimeter diameter maximum	9-05.1(7)
Perforated Concrete Underdrain Pipe	9-05.2(2)
Perforated Bituminized Fiber Underdrain Pipe	9-05.2(3)
Zinc Coated (Galvanized) Corrugated Iron, Aluminum Coated (Aluminized) Corrugated Iron, Zinc Coated (Galvanized) Steel, Aluminum Coated (Aluminized) Steel Underdrain Pipe	9-05.2(4)
Perforated Corrugated Aluminum Alloy Underdrain Pipe	9-05.2(5)
Perforated Polyvinyl Chloride (PVC) Underdrain Pipe, 200-millimeter diameter maximum	9-05.2(6)
Perforated Corrugated Polyethylene (PE) Underdrain Pipe, 200-millimeter diameter maximum	9-05.2(7)
Perforated Corrugated Polyethylene (PE) Underdrain Pipe, 300-millimeter through 600-millimeter diameter maximum	9-05.2(8)

Drain pipes may be concrete, zinc coated (galvanized) corrugated iron, aluminum coated (aluminized) corrugated iron, zinc coated (galvanized) steel, aluminum coated (aluminized) steel, corrugated aluminum alloy, polyvinyl chloride (PVC), or corrugated polyethylene (PE) at the option of the Contractor unless the Plans specify the type to be used.

Underdrain pipe, other than AASHTO M 36M Type III Class IV, shall be perforated. They may be concrete, bituminized fiber, zinc coated (galvanized) corrugated iron, aluminum coated (aluminized) corrugated iron, zinc coated (galvanized) steel, aluminum coated (aluminized) steel, corrugated aluminum alloy, polyvinyl chloride (PVC), or corrugated polyethylene (PE) at the option of the Contractor unless the Plans specify the type to be used.

It is not necessary that all drain or underdrain pipes on any one project be of the same kind of material; however, all contiguous pipe shall be of the same kind.

7-01.3 Construction Requirements

A trench of the dimensions shown in the Plans or as specified by the Engineer shall be excavated to the grade and line given by the Engineer. Drain pipe shall be laid in conformity with the line and grades as shown in the Plans. The drain pipe shall be laid with watertight joints unless otherwise specified.

PVC drain pipe shall be jointed with a bell and spigot joint using a flexible elastomeric seal as described in Section 9-04.8. The bell shall be laid upstream. PE drain pipe shall be jointed with snap-on, screw-on, or wraparound coupling bands as recommended by the manufacturer of the tubing.

When underdrain pipe is being installed as a means of intercepting ground or surface water, the trench shall be fine-graded in the existing soil 75 millimeters below the grade of the pipe as shown in the Plans. Gravel backfill shall be used under the pipe. Gravel backfill shall be placed to the depth shown in the Plans or as designated by the Engineer. All backfill shall be placed in 300 millimeter maximum layers and be thoroughly compacted with three passes of a vibratory compactor for each layer. The Contractor shall use care in placing the gravel backfill material to prevent its contamination.

When it is necessary to intercept water flowing underneath the roadway surfacing, the subgrade drain shall be constructed in accordance with the Standard Plan.

Concrete drain pipe shall be laid with the bell or larger end upstream.

All perforated pipe shall be laid with the perforations down. Upon final acceptance of the work, all drain pipes shall be open, clean, and free draining.

PVC underdrain pipe shall be jointed using either the flexible elastomeric seal as described in Section 9-04.8 or solvent cement as described in Section 9-04.9, at the option of the Contractor unless otherwise specified in the Plans. The bell shall be laid upstream. PE drainage tubing underdrain pipe shall be jointed with snap-on, screw-on, or wraparound coupling bands, as recommended by the manufacturer of the tubing.

7-01.4 Measurement

The length of drain or underdrain pipe will be the number of meters of completed installation measured along the invert. Pipe placed in excess of the length designated by the Engineer will not be measured or paid for.

Excavation of the trench will be measured as structure excavation Class B or structure excavation Class B including haul by the cubic meter as specified in Section 2-09.

Gravel backfill for drains will be measured by the volume placed within the neatline limits of structure excavation Class B.

7-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Drain Pipe ____ mm Diam.", per meter.
"Underdrain Pipe ____ mm Diam.", per meter.
"Gravel Backfill for Drain", per cubic meter.
"Structure Excavation Class B", per cubic meter.
"Structure Excavation Class B Incl. Haul", per cubic meter.

7-02 CULVERTS

7-02.1 Description

This work shall consist of constructing culverts of the various types and classes in accordance with the Plans, these Specifications, and the Standard Plans, at the locations as staked.

Culverts may be used for transverse drains under the roadway or as conduits for water pipe or other utilities passing under the roadway.

7-02.2 Materials

Materials shall meet the requirements of the following sections:

Plain Concrete Culvert Pipe	9-05.3(1)
Reinforced Concrete Culvert Pipe	9-05.3(2)
Beveled Concrete End Sections	9-05.3(3)
Steel Culvert Pipe and Pipe Arch	9-05.4
Steel Nestable Pipe and Pipe Arch	9-05.4(8)
Steel End Sections	9-05.4(9)
Aluminum Culvert Pipe	9-05.5
Aluminum End Sections	9-05.5(6)
Solid Wall PVC Culvert Pipe	9-05.12(1)
Profile Wall PVC Culvert Pipe	9-05.12(2)
Corrugated Polyethylene Culvert Pipe	9-05.19

Where steel or aluminum are referred to in this Section in regard to a kind of culvert pipe, pipe arch, or end sections, it shall be understood that steel is zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel, and aluminum is corrugated aluminum alloy as specified in Sections 9-05.4 and 9-05.5.

Thermoplastic culvert pipe includes solid wall PVC culvert pipe, profile wall PVC culvert pipe, and corrugated polyethylene culvert pipe. Solid wall PVC culvert pipe and profile wall PVC culvert pipe are acceptable alternates for Schedule A or B culvert pipe. Corrugated polyethylene culvert pipe is an acceptable alternate for Schedule A culvert pipe.

It is not necessary that all culvert pipe on any one project be of the same kind of material. However, all contiguous pipe shall be of the same size, material, thickness, class, and treatment and shall be that required for the maximum height of cover.

Alternate pipe installations shown in the Plans may be constructed provided there is no increase in the cost to the State.

Measurement for payment of the bid items associated with the drainage installation will be based on the diameter of the culvert pipe described by the bid item in the proposal.

If the Contractor elects to use an alternate installation, plans for the alternate shall be submitted to the Engineer for approval prior to procuring or constructing the alternate.

When schedule A, B, C, or D culvert pipe is specified in the Plans, the Contractor shall provide the specified schedule and diameter but has the option of furnishing any of the acceptable materials shown in the Culvert Pipe Schedules Table.

The use of tongue and groove concrete pipe shall only be allowed under side road connections. All tongue and groove pipe shall be joined with cement mortar.

Beveled end sections shall be of the same material as the culvert pipe to which they are attached.

Culvert Pipe Schedules

Schedule (Fill Height)	Diameter in Inches	Concrete	Steel 68 mm x 13 mm	Aluminum 68 mm x 13 mm	Thermoplastic PE[1] or PVC[2]
A 0.6 - 4 m	300, 450, 600	Plain or CI. IV	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	PE or PVC
	750, 900	Class III	1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	PE or PVC
	1050, 1200	Class III	1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	PE or PVC
B 4 - 8 m	300, 450, 600	Class V	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	PVC
	750, 900	Class V	1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	PVC
	1050, 1200	Class V	1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	PVC
C 8 - 12 m	300, 450, 600	None	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	None
	750, 900	None	1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	None
	1050, 1200	None	1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	None
D 12 - 20 m	300, 450,	None	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	None
	600	None	1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	None
	750, 900	None	1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	None
	1050, 1200	None	2.0 mm (14 Ga.)	3.5 mm (10 Ga.)	None

1. Corrugated polyethylene pipe.
2. Polyvinyl chloride pipe. Solid wall pr profile wall for diameters through 675 mm.
   Profile wall for diameters larger than 675 mm.

7-02.3 Construction Requirements

Culverts shall be constructed in accordance with Section 7-08.3.

7-02.3(1) Placing Culvert Pipe — General

A dike or plug of impervious material shall be placed near the intake end of the culvert to prevent piping. The dike shall be 0.6 meter long and adequately surround the pipe to form an impervious barrier. When suitable impervious materials are not available at the site, suitable backfill shall be obtained as provided in Section 2-09.3(1)E.

The ends of the pipe or pipe arch shall be rigidly supported to prevent movement before and during the construction of end walls or headers.

Culverts shall not be left extending beyond the staked limits unless approved by the Engineer.

All thermoplastic pipe shall be beveled to match the embankment or ditch slope but shall not be beveled flatter than 1:4. The minimum length of each section of pipe that is to be beveled shall be at least 6 times the diameter of the pipe when measured from the toe of the bevel to the joint.

7-02.3(2) Installation of Metal End Sections

Metal end sections shall be installed in accordance with the requirements of the Standard Plans, the Plans, and applicable portions of these Specifications.

When flared metal end sections are installed on concrete pipe, Design B end sections will be used on the inlet end only. Design C end sections will be used on the outlet ends only according to the following schedule:

Concrete Pipe Nominal Dia. in Millimeters	End Section Nominal Dia. in Millimeters
300	375
450	600
600	750
750	900
900	1050
1050	1200
1200	1500
1350	1650
1500	1800
1650	1950
1800	2100

7-02.3(3) Headwalls

If headwalls are specified in the Plans, they shall be constructed as soon as the embankment has been completed to a sufficient height over the structure to allow the required work. Headwalls shall be constructed in accordance with applicable portions of Section 6-02.

7-02.3(4) Removing and Relaying Culverts

Where shown in the Plans or where designated by the Engineer, existing culverts shall be removed and relaid in accordance with these Specifications. Any culvert damaged by the Contractor's operations shall be replaced by the Contractor at no expense to the Contracting

Agency. In the case of concrete pipe, all joints of the pipe before being relaid shall be cleaned so as to be free from all adhering material, including old mortar placed as a collar or seal in the original construction.

All culvert sections removed and not relaid shall become the property of the Contractor.

7-02.3(5) Safety Bars for Culvert Pipe

When shown in the Plans, safety bars for culvert pipe shall be constructed in accordance with the Standard Plans and shall meet the requirements of Section 9-05.18.

7-02.4 Measurement

The length of culvert pipe or pipe arch will be the number of meters of completed installation measured along the invert. Pipe placed in excess of the length designated by the Engineer will not be measured or paid for.

Beveled end sections will be considered as part of the culvert pipe and shall be measured as culverts.

Flared steel and aluminum end sections will be measured by the number of integral units of the dimension specified including toe plate extensions if called for in the Plans.

The pipe connector section of end section Design A shall be fabricated as a part of the integral unit of the end section but will be measured as meter of pipe or pipe arch of the treatment, thickness and dimensions of pipe to which it is attached. If there is no bid item for pipe of the proper dimensions for the end sections, the pipe connector sections will be considered as part of the integral unit and will not be measured as pipe.

Pipe connector sections of end section Design B will be considered part of the integral unit and measurement will be by number of integral units of the type and dimension specified.

The length of safety bars for culvert pipe will be the number of meters of each safety bar installed.

Tapered end Section with safety bars will be measured by the unit per each.

7-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Schedule ____ Culv. Pipe ____ mm Diam.", per meter.
"Plain Conc. Culv. Pipe ____ mm Diam.", per meter.
"Cl. ____ Reinf. Conc. Culv. Pipe ____ mm Diam.", per meter.
"Plain St. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Tr. ____ St. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Plain St. Culv. Pipe Arch ____ mm Th. ____ mm Span", per meter.
"Tr. ____ St. Culv. Pipe Arch ____ mm Th. ____ mm Span", per meter.
"Plain Nestable St. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Tr. ____ Nestable St. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Plain Al. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Plain Al. Culv. Pipe Arch ____ mm Th. ____ mm Span", per meter.
"Relaying (type of Pipe and Size)", per meter.
"Solid Wall PVC Culv. Pipe ____ mm Diam.", per meter.
"Profile Wall PVC Culv. Pipe ____ mm Diam.", per meter.
"Corrugated Polyethylene Culv. Pipe ____ mm Diam.", per meter.

Where culvert pipes are to be removed but are not to be relaid, all costs in connection with the removal shall be included in the unit contract price per cubic meter for “Structure Excavation Class B” or “Structure Excavation Class B Incl. Haul”.

“Flared End Section ____ mm Diam.”, per each.

“Flared End Section ____ mm Span”, per each.

“Safety Bars for Culvert Pipe Type ____”, per meter.

“Tapered End Sect. with Type ____ Safety Bars ____ mm Diam.”, per each.

7-03 STRUCTURAL PLATE PIPE, PIPE ARCH, ARCH, AND UNDERPASS

7-03.1 Description

This work shall consist of constructing structural plate pipe, pipe arches, arches, and underpasses of the various types and designs in accordance with the Plans, these Specifications, and the Standard Plans, at the locations and in conformity with the lines and grades staked.

Structural plate pipes shall be full circle of the type, gage or thickness, and diameter specified.

Structural plate pipe arches shall be a multi-centered shape made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis and of the type, gage or thickness, and span specified.

Structural plate arches shall be a single-centered circular arc shape, placed on a reinforced concrete foundation, and of the design, type, gage or thickness, and span as provided for in the Plans.

Structural plate underpasses shall be a multi-centered shape made up of a variable number of circular arcs tangent to each other at their junctions and symmetrical about the vertical axis and of the design, type, gage or thickness, and span specified.

7-03.2 Materials

Materials shall meet the requirements of the following sections:

Concrete Class 20	6-02
Corrugated Steel	9-05.6(8)
Corrugated Aluminum	9-05.6(8)
Reinforcing Steel	9-07

Alternate installations shown in the proposal may be constructed provided there is no increase in the total cost of the installation or detriment to the Contracting Agency.

Measurement for payment of the bid items associated with the drainage installation will be based on the size of the installation described by the bid item in the proposal.

If the Contractor elects to use an alternate installation, plans for the alternate shall be submitted to the Engineer for approval prior to procuring or constructing the alternate.

7-03.3 Construction Requirements

7-03.3(1) Foundations, General

Structural plate pipes, pipe arches, underpasses, and bases for arches shall be placed on stable foundations prepared to the widths, depth, and grade given by the Engineer. Soft spots encountered in the base shall be excavated to a depth designated by the Engineer and be backfilled with gravel or other suitable material and thoroughly compacted.

Rock, in either ledge or boulder formation, hard pan, or cemented gravel occurring in the base material shall be excavated below grade and backfilled with suitable material so there will be a minimum 200-millimeter cushion under the pipes, pipe arches, or underpasses.

7-03.3(1)A Structural Plate Pipe, Pipe Arch, and Underpass

The base for structural plate pipes, pipe arches and underpasses shall be shaped to conform to their bottom and shall form firm and uniform bearing throughout their length. Where pipes, pipe arches, or underpasses are to be installed in new embankment, the embankment shall be constructed to the $^{1}/_{3}$ point of structural plate pipes (measured from

the invert of the pipe), to the height of maximum horizontal dimension of structural plate pipe arches and as provided for in the Standard Plan or, in the case of a special design, in the Plans for structural plate underpasses, after which the trench shall be excavated and installation made.

7-03.3(1)B Structural Plate Arch

The base for structural plate arches shall be as shown in the Plans.

7-03.3(2) Assembling

Structural plate pipes, pipe arches, arches, and underpasses shall be assembled in place in accordance with the manufacturer's instructions, which shall accompany the shipment of materials and show the position of each plate and the order of assembly.

Bolts and bolted connections shall conform to the requirements of AASHTO M 167M for steel and AASHTO M 219M for aluminum.

7-03.3(3) Backfilling

After the structural plate pipe, pipe arch, arch, or underpass has been placed in position it shall be backfilled in accordance with Section 7-08.3(3).

7-03.3(4) Invert Treatment

Earth, or other material as specified, shall be placed and compacted in the invert of structural plate pipes, pipe arches, or underpasses in conformance with the Plans, Special Provisions, or the Standard Plan.

7-03.3(5) Headwalls

If headwalls are specified in the Plans, they shall be constructed as soon as the embankment has been completed to a sufficient height over the structure to allow the required work. Headwalls shall be constructed in accordance with the applicable portions of Section 6-02.

7-03.3(6) Safety Bars for Culvert Pipe

When shown in the Plans, safety bars for culvert pipe shall be constructed in accordance with the Standard Plans and shall meet the requirements of Section 9-05.18.

7-03.4 Measurement

The length of structural plate pipes, pipe arches, arches, and underpasses will be the number of meters of completed installation measured along the invert. Pipe placed in excess of the length designated by the Engineer will not be measured or paid for.

Concrete will be measured by the cubic meter as specified in Section 6-02.

Steel reinforcing bars will be measured by the kilogram as specified in Section 6-02.

Structure excavation Class B and structure excavation Class B including haul will be measured by the cubic meter as specified in Section 2-09.4.

Gravel backfill for foundation Class A or Class B will be measured by the cubic meter as specified in Section 2-09.4.

Shoring or extra excavation will be measured as specified in Section 2-09.4.

The length of safety bars for culvert pipe will be the number of meters of each safety bar installed.

Tapered end Section with safety bars will be measured by the unit per each.

7-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"St. Str. Plate Pipe ____ Gage ____ mm Diam.", per meter.

"St. Str. Plate Pipe Arch ____ Gage ____ m Span", per meter.

"St. Str. Plate Arch ____ Gage ____ m Span", per meter.

"Design ____ St. Underpass ____ Gage ____ m Span", per meter.

All costs involved in obtaining, hauling, placing, and finishing earth to be placed in the invert of the underpass shall be included in the unit contract price for "Design ____ St. Underpass ____ Gage ____ m Span".

"Al. Str. Plate Pipe ____ mm Th. ____ mm Diam.", per meter.

"Al. Str. Plate Pipe Arch ____ mm Th. ____ m Span", per meter.

"Al. Str. Plate Arch ____ mm Th. ____ m Span", per meter.

"Design ____ Al. Underpass ____ mm Th. ____ m Span", per meter.

All costs involved in obtaining, hauling, placing, and finishing earth to be placed in the invert of the underpass shall be included in the unit contract price for "Design ____ Al. Underpass ____ mm Th. ____ m Span".

"Conc. Class ____", per cubic meter.

The unit contract price per cubic meter for "Conc. Class ____" shall be paid as specified in Section 6-02.

"St. Reinf. Bar", per kilogram.

The unit contract price per kilogram for "St. Reinf. Bar" shall be paid as specified in Section 6-02.

"Structure Excavation Class B", per cubic meter.

"Structure Excavation Class B Incl. Haul", per cubic meter.

"Gravel Backfill for Foundation Class ____", per cubic meter.

"Shoring or Extra Excavation Class B", per square meter.

"Safety Bars for Culvert Pipe Type ____", per meter.

"Tapered End Section with Type ____ Safety Bars ____ mm Diam.", per each.

"Tapered End Section with Type ____ Safety Bars ____ mm Span", per each.

7-04 STORM SEWERS

7-04.1 Description

This work shall consist of constructing storm sewer lines in accordance with the Plans, these Specifications, and the Standard Plans, as staked.

7-04.2 Materials

Materials shall meet the requirements of the following sections:

Plain Concrete Storm Sewer Pipe	9-05.7(1)
Reinforced Concrete Storm Sewer Pipe	9-05.7(2)
Steel Spiral Rib Storm Sewer Pipe	9-05.9
Steel Storm Sewer Pipe	9-05.10
Aluminum Storm Sewer Pipe	9-05.11
Solid Wall PVC Storm Sewer Pipe	9-05.12(1)
Profile Wall PVC Storm Sewer Pipe	9-05.12(2)
Aluminum Spiral Rib Storm Sewer Pipe	9-05.17
Corrugated Polyethylene Storm Sewer Pipe	9-05.20

Where steel or aluminum are referred to in this Section in regard to a kind of storm sewer pipe, it shall be understood that steel is zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel and aluminum is corrugated aluminum alloy as specified in Sections 9-05.4 and 9-05.5.

Thermoplastic storm sewer pipe includes solid wall PVC storm sewer pipe, profile wall PVC storm sewer pipe, and corrugated polyethylene storm sewer pipe.

Alternate pipe installations shown in the Plans may be constructed provided there is no increase in the total cost of the installation or detriment to the Contracting Agency.

Measurement for payment of the bid items associated with the storm sewer installation will be based on the diameter of the storm sewer pipe described by the bid item in the Plans.

If the Contractor elects to use an alternate installation, plans for the alternate shall be submitted to the Engineer for approval prior to procuring or constructing the alternate.

It is not ncessary that all storm sewer pipe on any one project be of the same kind of material. However, all contiguous pipe shall be of the same size, material, thickness, class, and treatment and shall be that required for the maximum height of cover.

When schedule A or B storm sewer pipe is specified in the Plans, the Contractor shall provide the specified schedule and diameter but has the option of furnishing any of the acceptable materials shown in the Storm Sewer Pipe Schedules Table.

Storm Sewer Pipe Schedules

Schedules (Fill Ht.)	Dia. (mm)	Concrete	PVC[1]	PE[2]	Steel[3] 68 mm x 13 mm or Spiral Rib	Aluminum 68 mm x 13 mm • Tr. 5 • Plain With Gasketed Seams	Aluminum Spiral Rib • Tr. 5 • Plain With Gasketed Seams
	300	Plain or Cl. IV	SW or PW	Allowed	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	1.5 mm (16 Ga.)
	450	Plain or Cl. IV	SW or PW	Allowed	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	1.5 mm (16 Ga.)
A	600	Plain or Cl. IV	SW or PW	Allowed	1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	1.5 mm (16 Ga.)
0.6 m - 4 m	750	Class III	PW	Allowed	1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	1.5 mm (16 Ga.)
	900	Class III	PW	Allowed	1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	1.5 mm (16 Ga.)
	1050	Class III	PW	Allowed	1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	1.9 mm (14 Ga.)
	1200	Class III	PW	Allowed	1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	1.9 mm (14 Ga.)
	300	Class V	SW or PW		1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	1.5 mm (16 Ga.)
	450	Class V	SW or PW		1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	1.5 mm (16 Ga.)
B	600	Class V	SW or PW		1.6 mm (16 Ga.)	1.5 mm (16 Ga.)	1.5 mm (16 Ga.)
4 m - 8 m	750	Class V	PW		1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	1.9 mm (14 Ga.)
	900	Class V	PW		1.6 mm (16 Ga.)	1.9 mm (14 Ga.)	2.7 mm (12 Ga.)
	1050	Class V	PW		1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	2.7 mm (12 Ga.)
	1200	Class V	PW		1.6 mm (16 Ga.)	2.7 mm (12 Ga.)	2.7 mm (12 Ga.)

1. PVC = Polyvinyl Chloride Pipe, SW = Solid Wall PVC, PW = Profile Wall PVC
2. PE = Corrugated Polyethylene Pipe
3. Steel pipe options for either 68 mm x 13 mm corrugations or spiral rib include: Tr. 5 galvanized, Tr. 2 galvanized with gasketed seams, Tr. 5 aluminized, or plain aluminized with gasketed seams.

7-04.3 Construction Requirements

Storm sewers shall be constructed in accordance with Section 7-08.3.

7-04.3(1) Cleaning and Testing

7-04.3(1)A General

The requirements of Section 7-17.3(2)A shall apply to storm sewers.

7-04.3(1)B Exfiltration Test — Storm Sewers

Prior to making exfiltration leakage tests, the Contractor may fill the pipe with clear water to permit normal absorption into the pipe walls.

Leakage shall be no more than 5 liters per hour per meter of diameter per meter of storm sewer pipe, with a minimum test pressure of 2 meters of water column above the crown at the upper end of the pipe or above the active ground water table, whichever is higher as determined by the Engineer. The length of pipe tested shall be limited so that the pressure on the invert of the lower end of the Section tested shall not exceed 5 meters of water column. For each increase in pressure of 0.5 meter above a basic 2 meters measured above the crown at the lower end of the test section, the allowable leakage shall be increased by 10 percent.

7-04.3(1)C Infiltration Test — Storm Sewers

Whenever the ground water table is above the crown of the higher end of the pipe section at the time of testing, an infiltration test may be performed in lieu of the exfiltration test upon written permission of the Engineer. The maximum allowable limit for infiltration shall be 4 liters per hour per meter of diameter per meter of length with no allowance for external hydrostatic head.

7-04.3(1)D Other Test Allowances — Storm Sewers

Other allowances for infiltration and exfiltration tests shall be in accordance with Section 7-17.3(2)D.

7-04.3(1)E Low Pressure Air Test for Storm Sewers Constructed of Air-Permeable Materials

When air-permeable pipe is subjected to a low pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than the required time as shown in the table below:

Time in Seconds for Pressure Drop

Pipe Dia. (mm)	Pipe Length (meters) 20	40	60	80	100	120	140	160	180	200
100	6	12	17	23	29	35	41	47	52	57
150	13	26	39	52	66	79	85	85	85	85
200	23	27	70	93	113	113	113	113	120	133
250	36	73	109	142	142	142	146	167	187	208
300	52	105	157	170	170	180	210	240	270	300
375	82	164	213	213	234	281	330	380	420	470
450	118	236	255	270	340	410	470	540	610	680
525	161	298	298	370	460	550	650	740	830	920
600	210	340	360	480	600	720	840	960	1080	1200
675	266	390	460	610	760	910	1070	1220	1370	1520
750	330	430	560	750	940	1130	1310	1500	1680	1880

All time values listed in the table are in seconds. If a section to be tested includes more than one pipe size, the total time required can be found by adding the time values for each size of pipe and its corresponding length. Interpolate between values for pipe lengths not shown.

Pipe over 750 mm in diameter shall be tested one joint at a time in accordance with ASTM C 1103M.

7-04.3(1)F Low pressure Air Test for Storm Sewers Constructed of Non Air-Permeable Materials

When non air-permeable pipe is subjected to a low pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than 4 times the time shown in the table listed in Section 7-04.3(1)E.

Pipe over 750 mm in diameter shall be tested one joint at a time in accordance with ASTM C 1103M.

7-04.4 Measurement

The length of storm sewer pipe will be the number of meters of completed installation measured along the invert and will include the length through elbows, tees, and fittings. The number of meters will be measured from the center of manhole to center of manhole or to the inside face of catch basins and similar type structures.

The length of testing storm sewer pipe in conformance with Section 7-17.3(2)A will be the number of meters of completed installation actually tested.

7-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Plain Conc. Storm Sewer Pipe ____ mm Diam.", per meter.
"Class ____ Reinf. Conc. Storm Sewer Pipe ____ mm Diam.", per meter.
"Tr. ____ St. Storm Sewer Pipe ____ mm Th. ____ mm Diam.", per meter.
"Tr. ____ Al. Storm Sewer Pipe ____ mm Th. ____ mm Diam.", per meter.
"Solid Wall PVC Storm Sewer Pipe ____ mm Diam.", per meter.
"Profile Wall PVC Storm Sewer Pipe ____ mm Diam.", per meter.
"Corrugated Polyethylene Storm Sewer Pipe ____ mm Diam.", per meter.
"Schedule ____ Storm Sewer Pipe ____ mm Diam.", per linear foot.

The unit contract price per meter for storm sewer pipe of the kind and size specified shall be full pay for all work to complete the installation, including adjustment of inverts to manholes.

"Testing Storm Sewer Pipe", per meter.

7-05 MANHOLES, INLETS, CATCH BASINS, AND DRYWELLS

7-05.1 Description

This work shall consist of constructing manholes, inlets, drywells, and catch basins and connecting to existing structures of the types and sizes designated in accordance with the Plans, these Specifications, and the Standard Plans, in conformity with the lines and grades staked.

7-05.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Crushed Surfacing Base Course	9-03.9(3)
Gravel Backfill For Drywells	9-03.12(5)
Rubber Gaskets	9-04.4
Flexible Plastic Gaskets	9-04.5
Metal Castings	9-05.15
Grate Inlets and Drop Inlets	9-05.16
Reinforcing Steel	9-07
Concrete Blocks	9-12.1
Concrete Brick	9-12.2
Precast Concrete Manhole	9-12.4
Precast Concrete Catch Basis	9-12.5
Precast Concrete Drywells	9-12.7
Underground Drainage Geotextile, Moderate Survivability	9-33.1

7-05.3 Construction Requirements

The excavation for all manholes, inlets, and catch basins shall be sufficient to leave 300 millimeters in the clear between their outer surfaces and the earth bank.

The excavation for drywells shall be in accordance with the Standard Plans. The drywell and gravel backfill for drywell shall be completely encased in moderate survivability underground drainage geotextile in accordance with the Standard Plans and in conformance with Section 2-12.3. During construction of the drywell, all necessary precautions shall be taken to prevent debris and eroded material from entering the drywell.

The cover or grating of a manhole, catch basin, or inlet shall not be grouted to final grade until the final elevation of the pavement, gutter, ditch, or sidewalk in which it is to be placed has been established, and until permission thereafter is given by the Engineer to grout the cover or grating in place. Covers shall be seated properly to prevent rocking.

The channels in manholes shall conform accurately to the sewer grade.

Ladder rungs shall be grouted in the precast concrete walls. Rungs shall be uniformly spaced at 300 millimeters and be vertically aligned.

In the event any pipe enters the manhole through the precast concrete units, the Contractor shall make the necessary cut through the manhole wall and steel mesh. The steel shall be cut flush with the face of the concrete and shall be cut in such a manner that it will not loosen the reinforcement in the manhole wall.

The ends of all pipes shall be trimmed flush with the inside walls.

Rubber gaskets or flexible plastic gaskets may be used in tongue and groove joints of precast units. Joints between precast manhole units used for sanitary sewers shall be rubber gasketed. All other joints and all openings cut through the walls shall be grouted and watertight. Mortar shall conform to the requirements of Section 9-04.3.

If gaskets are used, handling of the precast units after the gasket has been affixed shall be done carefully to avoid disturbing or damaging the gasket or contaminating it with foreign material. Care shall be exercised to attain proper alignment before the joints are entirely forced home. During insertion of the tongue or spigot, the units shall be partially supported to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned.

Rigid pipes connecting to sanitary sewer manholes shall be provided with a flexible joint at a distance from the face of the manhole of not more than $1^1/_2$ times the nominal pipe diameter or 450 millimeters, whichever is greater.

Flexible pipes connecting to sanitary sewer manholes shall be provided with an entry coupling or gasket approved by the Engineer. No pipe joint in flexible pipe shall be placed within 3 meters of the manhole.

Backfilling around the work will not be allowed until the concrete or mortar has thoroughly set.

Catch basins, manholes, and inlets shall be watertight.

Catch basin, grate inlet, and drop inlet connections to a sewer shall be so placed that the connecting pipe may be easily rodded over its entire length. After the connections are made, the Contractor shall rod all inlet and outlet pipes. All connections that cannot be successfully rodded shall be removed and new connections made.

Backfilling of manholes, inlets, catch basins, and drywells shall be done in accordance with the provisions of Section 2-09.

Manholes, catch basins, inlets, and drywells shall be constructed on a compacted or undisturbed level foundation. If the Contractor elects to use a separate cast-in-place base, the concrete shall be Class 28. Upon final acceptance of the work, all manholes, catch basins, inlets, drywells, and other drainage structures shall conform to the requirements of the Standard Plan except as approved by the Engineer.

Any shoring or extra excavation required shall meet the requirements of Section 2-09.3.

7-05.3(1) Adjusting Manholes and Catch Basins to Grade

Where shown in the Plans or where directed by the Engineer, the existing manholes, catch basins, or inlets shall be adjusted to the grade as staked or otherwise designated by the Engineer.

The existing cast iron ring and cover on manholes and the catch basin and inlet frame and grate shall first be removed and thoroughly cleaned for reinstalling at the new elevation. From that point, the existing structure shall be raised or lowered to the required elevation. The materials and method of construction shall conform to the requirements specified above, and the finished structure shall conform to the requirements of the Standard Plan except as approved by the Engineer.

7-05.3(2) Abandon Existing Manholes

Where it is required that an existing manhole be abandoned, the structure shall be broken down to a depth of at least 1.2 meters below the revised surface elevation, all connections plugged, and the manhole filled with sand and compacted to 90 percent density

as specified in Section 2-03.3(14)C. Debris resulting from breaking the upper part of the manhole may be mixed with the sand subject to the approval of the Engineer. The ring and cover shall be salvaged and all other surplus material disposed of.

7-05.3(3) Connections to Existing Manholes

The Contractor shall verify invert elevations prior to construction. The crown elevation of laterals shall be the same as the crown elevation of the incoming pipe unless specified. The existing base shall be reshaped to provide a channel equivalent to that specified for a new manhole.

The Contractor shall excavate completely around the manhole to prevent unbalanced loading. The manhole shall be kept in operation at all times and the necessary precautions shall be taken to prevent debris or other material from entering the sewer, including a tight pipeline bypass through the existing channel if required. Water used for flushing and testing shall not be allowed to enter the sewer.

All damage to the manhole resulting from the Contractor's operation shall be repaired at no expense to the Contracting Agency.

7-05.3(4) Drop Manhole Connection

Drop manhole connections shall be constructed in accordance with the Plans. One length of ductile iron pipe shall be provided outside the manhole.

7-05.4 Measurement

Manholes will be measured per each. In addition to the measurement per each, manholes in excess of 3 meters in height will be measured per meter for each additional 0.5 meter of height over 3 meters. Measurement of manhole heights for payment purposes will be the distance from the flow line of the outlet pipe to the top of the manhole ring measured to the nearest 0.5 meter.

Catch basins and inlets, will be measured per each.

Adjustment of manholes, catch basins, and inlets will be per each.

Structure excavation Class B and structure excavation Class B including haul will be measured by the cubic meter as specified in Section 2-09.

Abandon existing manholes will be measured per each.

Connections to existing drainage structures will be measured per each.

Shoring or extra excavation will be measured as specified in Section 2-09.4.

Drop manhole connections will be measured per each.

Precast concrete drywell will be measured per each.

7-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Manhole ____ mm Diam. Type ____", per each.

"Manhole Additional Height ____ mm Diam. Type ____", per meter.

"Catch Basin Type ____", per each.

"Catch Basin Type 2 ____ mm Diam.", per each.

All costs associated with furnishings and installing gravel backfill for bedding manholes and catch basins shall be included in the unit contract price for the item installed.

"Grate Inlet Type ____", per each.

"Drop Inlet Type ____", per each.

"Concrete Inlet", per each.

"Precast Concrete Drywell" per each.

The unit contract price per each for "Precast Concrete Drywell" shall be full pay for furnishing and installing the drywell, including all structure excavation, gravel backfill for drywell, crushed surfacing base course, and drainage geotextile.

"Adjust Manhole", per each.

"Adjust Catch Basin", per each.

"Adjust Inlet, per each.

The unit contract price per each for "Adjust Manhole", "Adjust Catch Basin", or "Adjust Inlet" shall be full pay for all costs necessary to make the adjustment including restoration of adjacent areas in a manner acceptable to the Engineer.

"Structure Excavation Class B", per cubic meter.

"Structure Excavation Class B Incl. Haul", per cubic meter.

Structure excavation for concrete inlets is considered incidental to the cost of the inlets and shall be included in the unit contract price for the concrete inlet.

"Abandon Existing Manhole", per each.

"Connection to Drainage Structure", per each.

"Shoring or Extra Excavation Class B", per square meter.

"Drop Manhole Connection", per each.

The price paid per drop connection is in addition to the price paid for manholes and for the specified sewer pipe that is replaced with ductile iron pipe.

7-07 CLEANING EXISTING DRAINAGE STRUCTURES

7-07.1 Description

This work shall consist of cleaning, removing, and disposing of all debris and obstructions from existing culvert pipes, storm sewer pipes, drains, inlet structures, manholes, box culverts, grates, trash racks, or other drainage features within the limits of the project.

7-07.2 Vacant

7-07.3 Construction Requirements

All pipes and drainage structures that require cleaning are identified in the Plans. They shall be cleaned by flushing, rodding, or whatever means are necessary to provide unobstructed drainage. All catch basin sumps, manholes, inlet and outlet structures, and debris racks shall also be freed of all dirt, rock, and debris. Existing drainage facilities shall be cleaned as a first order of work to enhance natural drainage off and through the project. They shall be kept clean throughout the life of the project and be clean upon final acceptance of the work.

7-07.4 Measurement

No specific unit of measurement will apply for the lump sum item of cleaning existing drainage structures when shown in the proposal.

7-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Cleaning Existing Drainage Structure", lump sum.

The lump sum contract price for "Cleaning Existing Drainage Structure" shall be full pay for performing all work as specified. In the event the contract does not include a bid item for cleaning existing drainage structure, such work, if required, shall be performed by the Contractor at agreed price or on the basis of force account as provided in Section 1-09.6.

7-08 GENERAL PIPE INSTALLATION REQUIREMENTS

7-08.1 Description

This information shall cover the general requirements for installing culverts, storm sewers, and sanitary sewers. The Contractor shall also follow Section 7-02, 7-04, or 7-17 as it applies to the specific kind of work.

7-08.2 Materials

Gravel Backfill for Foundations	9-03.12(1)
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)
Bedding Material for Thermoplastic Pipe	9-03.16

7-08.3 Construction Requirements

7-08.3(1) Excavation and Preparation of Trench

7-08.3(1)A Trenches

The length of trench excavation in advance of pipe laying shall be kept to a minimum and in no case shall exceed 50 meters unless specifically authorized by the Engineer.

The trench width shall be as specified in Section 2-09.4 and shall be excavated to the depth and grade as given by the Engineer.

Trenches must be of sufficient width in the pipe zone to permit proper installation and bedding of the pipe and to provide the required compaction of backfill. Above the top of the pipe zone, the Contractor may excavate to any width.

All ledgerock, boulders, and stones shall be removed to provide a minimum of 150 millimeters clearance under all portions of the pipe.

Placement of bedding material shall precede the installation of all pipe. This shall include necessary leveling of the native trench bottom or the top of the foundation material as well as placement and compaction of required bedding material to a uniform grade so that the entire length of pipe will be supported on a uniformly dense unyielding foundation.

When, after excavating to the foundation level, the material remaining in the trench bottom is determined to be unsuitable by the Engineer, excavation shall be continued to such additional depth and width as required by the Engineer. Unsuitable foundation materials shall be disposed of at an approved site. The trench foundation shall be backfilled to the bottom of the pipe zone with gravel backfill for foundations, gravel backfill for pipe zone bedding, or other suitable material, and compacted to form a uniformly dense, unyielding foundation.

All material excavated from trenches and piled adjacent to the trench shall be maintained so that the toe of the slope is at least 0.6 meter from the edge of the trench. It shall be piled to cause a minimum of inconvenience to public travel, and provision shall be made for merging traffic where necessary. Free access shall be provided to all fire hydrants, water valves, and meters; and clearance shall be left to enable free flow of storm water in gutters, conduits, or natural watercourses.

If any part of the excavated material meets the specifications of Section 9-03.12(3), the Engineer may require that such material, in the quantity required, be selectively removed, stockpiled separately, and used as pipe bedding instead of quantities of gravel backfill for pipe zone bedding. If material so stockpiled becomes contaminated, the Contractor shall furnish suitable material in an amount equal to that lost by contamination at no expense to the Contracting Agency. All costs involved in storing, protecting, re-handling, and placing the material shall be included in other items of work on the project.

Excavation for manholes and other structures connected to the pipelines shall be sufficient to provide a minimum of 300 millimeters between their surfaces and the sides of the excavation.

The Contractor shall furnish, install, and operate all necessary equipment to keep excavations above the foundation level free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property or nuisance to the public. Sufficient pumping equipment in good working condition shall be available at all times for all emergencies, including power outage, and shall have available at all times competent workers for the operation of the pumping equipment.

Where pipe is to be placed in a new embankment, the embankment shall be constructed as shown in the Plans or as designated by the Engineer for a distance each side of the pipe location of not less than five times the diameter and to a minimum height equal to one-half of the outside diameter of the pipe. The embankment material shall be compacted to 95 percent density and the moisture content at the time of compaction shall be between optimum and 3 percentage points below optimum as determined by the Compaction Control Tests specified in Section 2-03.3(14)D. The trench shall then be excavated to a width as specified in 2-09.4, and the pipe installed in accordance with the Standard Plan.

7-08.3(1)B Shoring

The Contractor shall provide all materials, labor, and equipment necessary to shore trenches to protect the work, existing property, utilities, pavement, etc., and to provide safe working conditions in the trench. The Contractor may elect to use any combination of shoring and overbreak, tunneling, boring, sliding trench shield, or other method of accomplishing the work consistent with applicable local, State, or Federal safety codes.

If workers enter any trench or other excavation 1.22 meters or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored. The Contractor alone shall be responsible for worker safety, and the Contracting Agency assumes no responsibility.

Upon completing the work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

Shoring to be removed, or moveable trench shields or boxes, shall be located at least $2^1/_2$ pipe diameters away from metal or thermoplastic pipe if the bottom of the shoring, shield, or box extends below the top of the pipe, unless a satisfactory means of reconsolidating the bedding or side support material disturbed by shoring removal can be demonstrated.

Damages resulting from improper shoring or failure to shore shall be the sole responsibility of the Contractor.

7-08.3(1)C Bedding the Pipe

Pipe zone bedding material shall provide uniform support along the entire pipe barrel, without load concentration at joint collars or bells. All adjustment to line and grade shall be made by scraping away or filling in with bedding material under the body of the pipe and not by blocking or wedging. Bedding disturbed by pipe movement, or by removal of shoring movement of a trench shield or box, shall be reconsolidated prior to backfill.

Pipe zone bedding shall be as specified in the Standard Plan and shall be placed in loose layers and compacted to 90 percent maximum density. Bedding shall be placed, spread, and compacted before the pipe is installed so that the pipe is uniformly supported along the

barrel. Lifts of not more than 150 millimeters in thickness shall be placed and compacted along the sides of the pipe to the height shown in the Standard Plan. Material shall be worked carefully under the pipe haunches and then compacted.

If the Engineer determines that the material existing in the bottom of the trench is satisfactory for bedding the pipe, the bedding material specified in the Standard Plan is not required, provided the existing material is loosened, regraded, and compacted to form a dense, unyielding base.

7-08.3(2) Laying Pipe

7-08.3(2)A Survey Line and Grade

Survey line and grade control hubs will be placed in a manner consistent with accepted practices.

The Contractor shall transfer line and grade into the trench where they shall be carried by means of a laser beam or taut grade line supported on firmly set batter boards at intervals of not more than 9 meters. Not less than three batter boards shall be in use at one time. Grades shall be constantly checked and in the event the batter boards do not line up, the work shall be immediately stopped, the Engineer notified, and the cause remedied before proceeding with the work. Any other procedure shall have the written approval of the Engineer.

7-08.3(2)B Pipe Laying — General

After an accurate grade line has been established, the pipe shall be laid in conformity with the established line and grade in the properly dewatered trench. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surfaces.

All pipe laid in the trench to the specified line and grade shall be kept in longitudinal compression until the backfill has been compacted to the crown of the pipe. All pipe shall be laid to conform to the prescribed line and grade shown in the plans, within the limits that follow.

Pipe shall be laid to a true line and grade at the invert of the pipe and the Contractor shall exercise care in matching pipe joints for concentricity and compatibility. In no case shall two pipes be joined together with ends having the maximum manufacturer's tolerance. The invert line may vary from the true line and grade within the limits stated to develop uniformity, concentricity, and uniform compression of jointing material provided such variance does not result in a reverse sloping invert. The limit of the variance at the invert shall not exceed plus or minus 9 millimeters at the time of backfill. Checking of the invert elevation of the pipe may be made by calculations from measurements on the top of the pipe.

The pipe, unless otherwise approved by the Engineer, shall be laid up grade from point of connection on the existing pipe or from a designated starting point. The pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an approved temporary plug.

Where pipe joints must be deflected within the manufacturer's recommended limits to accommodate required horizontal or vertical curvature, it shall first be joined in straight alignment and then deflected as required.

Where pipe joints must be deflected to an amount greater than the manufacturer's recommended limits to accommodate required horizontal or vertical curvature, the curves shall be achieved with a series of tangents and shop fabricated bends, subject to the approval of the Engineer.

Upon final acceptance of the work, all pipe and appurtenances shall be open, clean, and free draining.

7-08.3(2)C Pipe Laying — Concrete

For concrete pipe with elliptical reinforcement, the markings indicating the minor axis of the reinforcement shall be placed in a vertical plane (top or bottom) when the pipe is laid.

7-08.3(2)D Pipe Laying — Steel or Aluminum

Pipe with riveted or resistance spot welded seams shall be laid in the trench with the outside laps of circumferential joints upgrade and with longitudinal laps positioned other than in the invert, and firmly joined together with approved bands.

When plain aluminum pipe or pipe arch is used where it will be in contact with concrete or concrete pipe, all aluminum surfaces in contact with the concrete or concrete pipe shall be painted with two coats of paint. The aluminum pipe to be painted shall be cleaned with solvent to remove contaminants. After cleaning, the pipe shall be painted with two coats of paint conforming to Federal Specification TT-P-645 (Primer, Paint, Zinc Chromate, Alkyd Vehicle).

All costs of cleaning and painting the aluminum surfaces as specified shall be included in the unit contract price per meter for the aluminum pipe or pipe arch.

7-08.3(2)E Rubber Gasketed Joints

In laying pipe with rubber gaskets, the pipe shall be handled carefully to avoid knocking the gasket out of position or contaminating it with foreign material. Any gasket so disturbed shall be removed, cleaned, relubricated if required, and replaced before joining the sections.

The pipe shall be properly aligned before joints are forced home. Sufficient pressure shall be applied in making the joint to ensure that the joint is home, as defined in the standard installation instructions provided by the pipe manufacturer. The Contractor may use any method acceptable to the Engineer for pulling the pipe together, except that driving or ramming by hand or machinery will not be permitted. Any pipe damaged during joining and joint tightening shall be removed and replaced at no expense to the Contracting Agency.

Care shall be taken to properly align the pipe before joints are entirely forced home. During insertion of the tongue or spigot, the pipe shall be partially supported by hand, sling or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Since most gasketed joints tend to creep apart when the end of the pipe is deflected and straightened, such movement shall be held to a minimum once the joint is home.

Sufficient restraint shall be applied to the line to ensure that joints once home are held so by compacting backfill material under and alongside the pipe or by other acceptable means. At the end of the work day, the last pipe shall be blocked in such a manner as may be required to prevent creep.

7-08.3(2)F Plugs and Connections

Plugs for pipe branches, stubs, or other open ends which are not to be immediately connected shall be made of an approved material and shall be secured in a place with a joint comparable to the main line joint, or stoppers may be of an integrally cast breakout design.

7-08.3(2)G Jointing of Dissimilar Pipe

Dissimilar pipe shall be jointed by use of a factory-fabricated adapter coupling or a pipe collar as detailed in the Standard Plans.

7-08.3(2)H Sewer Line Connections

Storm and sanitary sewer line connections to trunks, mains, laterals, or side sewers shall be left uncovered until after the Engineer has inspected and approved the work. After approval of the connection, the trench shall be backfilled as specified.

7-08.3(2)I Side Sewer Connections

Where a storm or sanitary side sewer is larger than the trunk, main, or lateral to which it is to be connected, the connection shall be made only at a standard manhole unless otherwise provided in the Plans or in the Special Provisions, or unless otherwise authorized by the Engineer.

7-08.3(3) Backfilling

Placement of pipe zone backfill shall be performed in accordance with these requirements and the Standard Plan. Trenches shall be backfilled as soon after the pipe laying as possible.

Pipe zone backfill material shall be clean earth or sand, free from clay, frozen lumps, roots, or moisture in excess of that permitting required compaction. Rocks or lumps larger than 75 millimeters maximum shall not be used for pipe zone backfill.

Pipe zone backfill shall be placed in loose layers and compacted to 90 percent maximum density. Backfill shall be brought up simultaneously on each side of the pipe to the top of the pipe zone. The pipe shall then be covered to the top of the pipe zone and the materials compacted in a manner to avoid damaging or disturbing the completed pipe.

Backfill above the pipe zone shall be accomplished in such a manner that the pipe will not be shifted out of position nor damaged by impact or overloading. If pipe is being placed in a new embankment, backfill above the pipe zone shall be placed in accordance with Section 2-03.3(14)C. If pipe is being placed under existing paved areas, or roadways, backfill above the pipe zone shall be placed in horizontal layers no more than 150 millimeters thick and compacted to 95 percent maximum density. If pipe is being placed in non-traffic areas, backfill above the pipe zone shall be placed in horizontal layers no more than 150 millimeters thick and shall be compacted to 85 percent maximum density. All compaction shall be in accordance with the Compaction Control Test of Section 2-03.3(14)D. Material excavated from the trench shall be used for backfill above the pipe zone, except that organic material, frozen lumps, wood, rocks, or pavement chunks larger than 150 millimeters in maximum dimension shall not be used. Materials determined by the Engineer to be unsuitable for backfill at the time of excavation shall be removed and replaced with imported backfill material.

Backfilling of trenches in the vicinity of catch basins, manholes, or other appurtenances will not be permitted until the cement in the masonry has become thoroughly hardened.

When it is required that a blanket of select material or bank run gravel is to be placed on top of the native backfill, the backfill shall be placed to the elevations shown in the Plans, or to the elevations specified by the Engineer. Compaction of the native material shall be as required by the Contracting Agency and shall be performed prior to placing the select material. Surface material shall be loosened to whatever depth is required to prevent bridging of the top layer, but shall in no case be less than 450 millimeters.

The Contractor shall not operate tractors or other heavy equipment over the top of the pipe until the backfill has reached a height of 0.6 meter above the top of the pipe.

7-08.3(4) Plugging Existing Pipe

Where shown in the Plans or where designated by the Engineer, existing pipes shall be plugged on the inlet end for a distance of 2 diameters with commercial concrete. Care shall be used in placing the concrete in the pipe to see that the opening of the pipe is completely filled and thoroughly plugged.

7-08.4 Measurement

Gravel backfill for foundations, or gravel backfill for pipe zone bedding when used for foundations, shall be measured by the cubic meter, including haul, as specified in 2-09.

There will be no specific unit of measure for any material placed in the pipe zone in the installation of culvert, storm sewer, and sanitary sewer pipes.

Plugging pipes will be measured per each, for each plug installed, for pipe diameters up to and including 900 millimeters. The concrete for plugging pipes in excess of 900 millimeters in diameter will be measured by the cubic meter. Computation for corrugated metal pipes will be based on the nominal diameter.

Excavation of the trench will be measured as structure excavation Class B or structure excavation Class B including haul, by the cubic meter as specified in Section 2-09. When excavation below grade is necessary, excavation will be measured to the limits ordered by the Engineer.

Embankment construction before culvert placement under the applicable provisions of Section 7-08.3(1)A will be measured in accordance with Section 2-03.

Shoring or extra excavation class B will be measured as specified in Section 2-09.4.

7-08.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items that are included in the proposal:

"Gravel Backfill for Foundations Class ____", per cubic meter.

"Gravel Backfill for Pipe Zone Bedding", per cubic meter.

All costs associated with furnishing and installing bedding and backfill material within the pipe zone in the installation of culvert, storm sewer, and sanitary sewer pipes shall be included in the unit contract price for the type and size of pipe installed.

"Plugging Existing Pipe", per each.

"Commercial Concrete", per cubic meter.

"Structure Excavation Class B", per cubic meter.

"Structure Excavation Class B Incl. Haul", per cubic meter.

"Shoring or Extra Excavation Class B", per square meter.

All costs in jointing dissimilar pipe with a coupling or concrete collar shall be included in the unit contract price per foot for the size and type of pipe being jointed.

7-09 PIPE AND FITTINGS FOR WATER MAINS

7-09.1 Description

It is not intended that materials listed herein are to be necessarily considered equal or generally interchangeable for all applications. Those suitable for the project shall be specified in the Special Provisions or shown in the Plans.

7-09.2 Materials

Materials shall meet the requirements of the following sections:

Pipe	9-30.1
Ductile Iron Pipe	9-30.1(1)
Steel Pipe (150 mm and Over)	9-30.1(4)A
Steel Pipe (100 mm and Under)	9-30.1(4)B
Polyvinyl Chloride (PVC) Pipe (100 mm and Over)	9-30.1(5)A
Polyvinyl Chloride (PVC) Pipe (Under 100 mm)	9-30.1(5)B
Fittings	9-30.2
Ductile Iron Pipe	9-30.2(1)
Steel Pipe (150 mm and Over)	9-30.2(4)A
Steel Pipe (100 mm and Under)	9-30.2(4)B
Polyvinyl Chloride (PVC) Pipe (100 mm and Over)	9-30.2(5)A
Polyvinyl Chloride (PVC) Pipe (Under 100 mm)	9-30.2(5)B
Restrained Joints	9-30.2(6)
Bolted Sleeve-Type Couplings for Plain End Pipe	9-30.2(7)
Valves	9-30.3
Gate Valves (75 mm to 300 mm)	9-30.3(1)
Gate Valves (350 mm and 400 mm)	9-30.3(2)
Butterfly Valves	9-30.3(3)
Valve Boxes	9-30.3(4)
Valve Marker Posts	9-30.3(5)
Valve Stem Extension	9-30.3(6)
Combination Air Release Valves	9-30.3(7)
Tapping Sleeve and Valve Assembly	9-30.3(8)
Hydrants	9-30.5
Service Connections (50 mm and Smaller)	9-30.6

The pipe manufacturer shall test all pipe and fittings as required by these Specifications and the standards referenced. The pipe manufacturer shall submit to the Engineer two copies of all test results including a certification that material to be delivered is represented by the samples tested and that such delivered materials meets or exceeds the specified requirements. No pipe shall be delivered until test results and certifications are in the hands of the Engineer.

The Engineer shall have free access to all testing and records pertaining to material to be delivered to the job site. The Engineer may elect to be present at any or all material testing operations.

The basis of acceptance shall be a certificate of compliance as described in Section 1-06.3, accompanied by two copies of pressure test results of the pipe or fittings involved.

7-09.3 Construction Requirements

Installation of pipe and fittings is described in Section 7-11.

7-09.4 Measurement and Payment

Measurement of and payment for pipe and fittings are described in Sections 7-11.4 and 7-11.5.

7-10 TRENCH EXC., BEDDING, AND BACKFILL FOR WATER MAINS

7-10.1 Description

The work covered in this Section includes excavating, bedding, and backfilling water mains and appurtenances.

Water mains shall be constructed at the locations shown in the Plans.

Where grading is required, such grading as excavation and embankment shall conform to the requirements of Section 2-03, and rough grading shall be completed before excavating for the water main trench.

7-10.1(1) Definitions

7-10.1(1)A Trench Widths

Trench width is from trench wall to trench wall, outside of shoring.

7-10.1(1)B Unsuitable Material

Material removed because it is unsatisfactory for foundations is defined as unsuitable foundation material.

Material removed in trenching which is unsuitable for replacement in the backfill is defined as unsuitable backfill material.

7-10.1(1)C Bedding

Bedding is the method or material used to transmit load from the pipe into the foundation or into the side support.

7-10.1(1)D Backfill Materials

Backfill materials include all materials placed above the bedding up to the underside of the pavement or surfacing materials.

7-10.2 Materials

Materials shall meet the requirements of the following sections:

Foundation Material	9-03.17, 9-03.18
Bank Run Gravel for Trench Backfill	9-03.19

7-10.3 Construction Requirements

7-10.3(1) General

All trench excavation required for the installation of water mains and appurtenances shall be unclassified. All material excavated from trenches and piled adjacent to the trench or in a roadway or public thoroughfare shall be piled and maintained so that the toe of the slope of the spoil material is at least 0.6 meter from the edge of the trench. It shall be piled in a manner to prevent surface water from flowing into the excavation and in a manner that will cause a minimum of inconvenience to public travel. Free access shall be provided to all fire hydrants, water valves, and meters; and clearance shall be left to enable the free flow of storm water in all gutters, conduits, and natural watercourses.

7-10.3(2) Ungraded Streets

On ungraded streets, when grading is not called for in the Contract, the depth of trench excavation shall be as shown in the Plans and as staked.

Where the Plans show the pipe is to be laid above the existing ground surface, an embankment fill shall be made and compacted to conform with the section shown in the Plans, and the water main trench shall be excavated therein. That portion of the embankment below the bottom of the pipe shall be compacted with rollers or mechanical compactors under controlled moisture conditions as required under Method B of Section 2-03.3(14)C.

7-10.3(3) Clearing and Grubbing in Ungraded Streets

On ungraded streets, where clearing and grubbing is not called for in the Contract, the area to be excavated or filled shall be cleared and grubbed by the Contractor. This work shall consist of the removal and disposal of all logs, stumps, roots, brush, and other refuse within 1.5 meters of the centerline of the pipe. All such material shall be disposed of in accordance with the Special Provisions.

7-10.3(4) Removal of Existing Street Improvements

Removal of existing street improvements and pavement from driveways and sidewalks shall be performed as specified in Section 2-02. Stockpiling of waste materials along the trench will not be allowed.

7-10.3(5) Grade and Alignment

The Contractor shall verify the locations and establish the depth of the existing water mains at the points where connections are to be made prior to trenching for the pipelines. The profile shall be adjusted so neither a high spot or a low spot is created adjacent to the connection to the existing water mains.

The depth of trenching for water mains shall be such as to give a minimum cover of 0.9 meter over the top of the pipe unless otherwise specified in the Special Provisions. Deeper excavation may be required due to localized breaks in grade, or to install the new main under existing culverts or other utilities where necessary. Where the profile of the pipeline and the ground surface is shown in the Plans, the pipeline shall be laid to the elevation shown regardless of depth. The excavation shall be to such depth that the minimum cover over the valve nuts shall be 0.3 meter.

7-10.3(6) Existing Utilities

Existing utilities of record, except services, are shown in the Plans. These are shown for convenience only, and the Engineer assumes no responsibility for improper locations or failure to show utility locations in the Plans. The Contractor shall be responsible for protecting existing utilities as specified in Section 1-07.17 and shall be responsible for any damage as specified in Section 1-07.18.

When utility services occupy the same space as the new water main, the Contractor shall do all necessary excavation to fully expose such services. The Contractor shall protect said services, and work around them during excavating and pipe laying operations. Any damages to services resulting from the Contractor's operation shall be reported to the appropriate utility. Such damage shall be repaired at the Contractor's expense.

7-10.3(7) Trench Excavation

The Contractor shall perform all excavation of every description and in whatever materials encountered to the depth indicated in the Plans or specified in the Special Provisions. All excavations shall be made by open cut unless otherwise provided for. All

trenches shall be excavated to true and smooth bottom grades and in accordance with the lines given by the Engineer. The trench bottom shall provide uniform bearing and support for each length of pipe.

Bell holes shall be excavated to the extent necessary to permit accurate work in making and inspecting the joints. The banks of the trenches shall be kept as nearly vertical as soil conditions will permit, and where required to control trench width or to protect adjacent structures, the trench shall be sheeted and braced. Trench widths to 300 millimeters above the top of the pipe shall not exceed 750 millimeters maximum or $1^1/_2$ times the outside diameter of the pipe plus 450 millimeters whichever is greater. Standard excavating equipment shall be adjusted so as to excavate the narrowest trench possible.

Trench excavation shall be not more than 120 meters ahead of the pipe laying operation and all trenches shall be closed up at the end of the day.

The Contractor shall exercise sound engineering and construction practices in excavating the trench and maintaining it so that no damage will occur to any foundation, structure, pole line, pipe line, or other facility because of slough or slopes, or from any other cause. If, as a result of the excavation, there is disturbance of the ground which may endanger other property, the Contractor shall immediately take remedial action at no expense to the Contracting Agency. No act, representation, or instruction of the Engineer shall in any way relieve the Contractor from liability for damages or costs that result from trench excavation.

Care shall be taken not to excavate below the depth specified. Excavation below that depth shall be backfilled with select backfill material and compacted as specified herein.

If workers enter any trench or other excavation 1.22 meters or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored. The Contractor alone shall be responsible for worker safety, and the Contracting Agency assumes no responsibility.

The Contractor shall submit six sets of shoring plans for approval in accordance with Section 2-09.3(3)D. Excavation and shoring shall not proceed until the shoring plans have been approved by the Engineer.

Upon completing the work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

7-10.3(7)A Rock Excavation

Rock excavation shall cover the removal and disposal of rock that requires systematic drilling and blasting for its removal, and also boulders exceeding 0.3 cubic meter. Ledge rock, boulders, or stones shall be removed to provide a minimum clearance of 100 millimeters under the pipe.

Hardpan, hard clay, glacial till, sandstone, siltstone, shale, or other sedimentary rocks which are soft, weathered, or extensively fissured will not be classified as rock excavation. Rock is defined as one which has a modulus of elasticity of more than 1380 megapascals or unconfined compressive strength at field moisture content of more than 1.38 megapascals.

Materials removed shall be replaced with selected native materials from adjacent trenches or from imported bedding or backfill as designated by the Engineer.

7-10.3(7)B Extra Trench Excavation

Changes in grades of the water main from those shown in the Plans, or as provided in the Special Provisions, may be necessary because of unplotted utilities, or for other reasons. If, in the opinion of the Engineer, it is necessary to adjust, correct, relocate, or in any way change the line and grade, such changes shall be made by the Contractor under the terms of these Specifications.

When pipeline grade is lowered in excess of 300 millimeters below the grade indicated in the Plans, the Contractor shall make such extra excavation as necessary.

When the pipeline horizontal alignment is changed by more than 300 millimeters from the line indicated in the Plans, after the trench has been excavated, the Contractor shall excavate the trench at the changed location and backfill and compact the previous trench.

Additional excavation so required will be classified as extra trench excavation.

7-10.3(8) Removal and Replacement of Unsuitable Materials

Whenever in excavating the trench for water mains, the bottom of the trench exposes peat, soft clay, quicksand, or other unsuitable foundation material, such material shall be removed to the depth directed by the Engineer and backfilled with foundation material. When determined by the Engineer that silty soils or fine sandy soils are encountered, Class C foundation material will be required. Silty soils or fine sandy soils usually flow in the presence of a stream of water. When determined by the Engineer that clays, peats, or other soft materials are encountered that become saturated with water, but do not break down into fine particles and flow, Class A or Class B foundation material will be required.

Material removed from the trench that is unsuitable for backfill shall be removed and hauled to a waste site. If material is not available within the limits of the project for backfilling the trench, the Contractor shall furnish suitable material meeting the requirements of Section 9-03.19.

All unsuitable material shall be loaded directly into trucks and hauled to a waste site obtained by the Contractor. Stockpiling of unsuitable material at the project site will not be allowed.

7-10.3(9) Bedding the Pipe

Bedding material shall be select granular material free from wood waste, organic material, and other extraneous or objectionable materials and shall have a maximum dimension of 38 millimeters. Material shall be placed to a minimum depth of 100 millimeters under the pipe and 150 millimeters over the top of the pipe. The bedding material shall be rammed and tamped around the pipe to 95 percent of maximum density by approved hand-held tools, so as to provide firm and uniform support for the full length of the pipe, valves, and fittings. Care shall be taken to prevent any damage to the pipe or its protective coating.

7-10.3(10) Backfilling Trenches

Prior to backfilling, all form lumber and debris shall be removed from the trench. Sheeting used by the Contractor shall be removed just ahead of the backfilling.

Backfill up to 300 millimeters over the top of the pipe shall be evenly and carefully placed. Materials capable of damaging the pipe or its coating shall be removed from the backfill material. The remainder of the material shall be placed by dumping into the trench by any method at the option of the Contractor, and shall be compacted as specified hereinafter.

A minimum 75-millimeter sand cushion shall be placed between the water main and existing pipelines or other conduits when encountered during construction and as directed by the Engineer.

7-10.3(11) Compaction of Backfill

Backfill shall be compacted to at least 95 percent of maximum density as specified in Section 2-03.3(14)D.

At locations where paved streets, roadway shoulders, driveways, or sidewalks will be constructed or reconstructed over the trench, the backfill shall be spread in layers and be compacted by mechanical tampers. In such cases, the backfill material shall be placed in successive layers not exceeding 150 millimeters in loose thickness, and each layer shall be compacted with mechanical tampers to the density specified herein. Mechanical tampers shall be of the impact type as approved by the Engineer.

7-10.4 Measurement

No measurement shall be made for clearing and grubbing, removal of existing street improvements, protection of existing utilities and services, trench excavation and backfill, bedding the pipe, and compaction of backfill.

When listed as a pay item, rock excavation will be measured in its original position by volume in cubic meters. The quantity measured for payment will include only the material excavated from within the limits hereinafter defined. Any additional excavation outside of these limits will be considered as having been made for the Contractor's benefit, and all costs in connection with such excavation shall be included in the unit contract prices for the various items of work.

The horizontal limits for measuring rock excavation will be the sides of the trench, except no payment will be made for material removed outside of vertical planes extended beyond the maximum trench widths, as specified in Section 7-10.3(7). Vertical distances shall be measured from the upper surface of the rock to an elevation 150 millimeters below the underside of the pipe barrel, or to the lower surface of the rock, whichever is less. Boulders exceeding one cubic meter in volume shall be paid for according to their measured volume.

Removal of the extra trench excavation as defined in Section 7-10.3(7)B will be measured by the cubic meter. The depth shall be the actual depth removed for the changed line or grade in accordance with Section 7-10.3(5) or as directed by the Engineer. The width shall be the actual width removed for the changed line or grade, but in no case shall the measured width exceed the allowable widths specified in Section 7-10.3(7).

Removal and replacement of unsuitable material will be measured by the cubic meter. The depth shall be the actual depth removed below the depth specified in Section 7-10.3(5). The width shall be the actual width removed, but in no case shall the measured width exceed the allowable widths specified in Section 7-10.3(7).

Measurement of bank run gravel for trench backfill will be by the cubic meter measured in trucks at the point of delivery.

Shoring or extra excavation trench will be measured as specified in Section 2-09.4 for shoring or extra excavation Class B.

7-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Rock Excavation", per cubic meter.

If no pay item is listed, rock excavation shall be considered incidental to work to construct the water main and all costs shall be included in other items of work specified in Section 7-11.5.

"Extra Trench Excavation", per cubic meter.

"Removal and Replacement of Unsuitable Material", per cubic meter.

"Bank Run Gravel for Trench Backfill", per cubic meter.

No separate payment will be made for clearing and grubbing, removal of existing street improvements, furnishing and installing sand cushion, protection of existing utilities and services, trench excavation and backfill, bedding the pipe, and compacting the backfill. These items shall all be considered as incidental to the work of constructing the water main, and all costs thereof shall be included in the payment as specified in Section 7-11.5.

"Shoring or Extra Excavation Trench", per square meter.

7-11 PIPE INSTALLATION FOR WATER MAINS

7-11.1 General

Pipe shall be installed in accordance with the manufacturer's printed specifications and instructions, and to the standards of the AWWA for installing the type of pipe used. The Contractor shall provide all tools and equipment, including any special tools required for installing each particular type of pipe used.

Short lengths of pipe supplied by the manufacturer shall be used whenever possible to provide the proper spacing of valves, tees, or special fittings.

7-11.2 Materials

Materials shall meet the requirements of the following sections:

Concrete Blocking	6-02
Detectable Marking Tape	9-15.18
Pipe and Fittings	9-30.1, 9-30.2
Blowoff Assemblies	9-30.1, 9-30.2, 9-30.3, 9-30.6

7-11.3 Construction Requirements

7-11.3(1) Dewatering of Trench

Where water is encountered in the trench, it shall be removed during pipe-laying operations and the trench so maintained until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Trench water or other deleterious materials shall not be allowed to enter the pipe at any time.

7-11.3(2) Handling of Pipe

Pipe shall be handled in a manner that will prevent damage to the pipe, pipe lining, or coating. Pipe and fittings shall be loaded and unloaded using hoists and slings in a manner to avoid shock or damage, and under no circumstances shall they be dropped, skidded, or rolled against other pipe. If any part of the coating or lining is damaged, repair thereof shall be made by the Contractor at no expense to the Contracting Agency and in a manner satisfactory to the Engineer. Damaged pipe will be rejected, and the Contractor shall immediately place all damaged pipe apart from the undamaged and shall remove the damaged pipe from the site within 24 hours.

Threaded pipe ends shall be protected by couplings or other means until laid.

The pipe and fittings shall be inspected for defects.

Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations, and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned, and relaid. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by the Engineer to ensure cleanliness inside the pipe.

7-11.3(3) Cutting Pipe

Whenever it becomes necessary to cut a length of pipe, the cut shall be made by abrasive saw or by a special pipe cutter. All pipe ends shall be square with the longitudinal axis of the pipe and shall be reamed and otherwise smoothed so that good connections can be made. Threads shall be cleanly cut. Oxyacetylene torch cutting of ductile iron pipe shall not be allowed.

7-11.3(4) Laying of Pipe on Curves

7-11.3(4)A Ductile Iron Pipe

Long radius curves, either horizontal or vertical, may be laid with standard pipe by deflecting the joints. If the pipe is shown curved in the Plans and no special fittings are shown, the Contractor can assume that the curves can be made by deflecting the joints with standard lengths of pipe. If shorter lengths are required, the Plans will indicate maximum lengths that can be used. The amount of deflection at each pipe joint when pipe is laid on a horizontal or vertical curve shall not exceed the manufacturer's printed recommended deflections.

Where field conditions require deflection or curves not anticipated by the Plans, the Engineer will determine the methods to be used. No additional payment will be made for laying pipe on curves as shown in the Plans, nor for field changes involving standard lengths of pipe deflected at the joints. When special fittings not shown in the Plans are required to meet field conditions, additional payment will be made for special fittings as provided in Section 1-09.6.

When rubber gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. Trenches shall be made wider on curves for this purpose.

7-11.3(4)B Polyvinyl Chloride (PVC) Pipe (100 Millimeters and Over)

PVC pipe 300 millimeters and under may be bent to allow for slight changes in direction. The minimum bending radius shall be as follows:

Size	Minimum Bending Radius
100-millimeter	40 meters
150-millimeter	55 meters
200-millimeter	70 meters
250-millimeter	85 meters
300-millimeter	100 meters

Axial deflection at the pipe joints shall not be allowed.

PVC Pipe 350 millimeters in diameter may be bent to a minimum radius of 120 meters. For 400-millimeter diameter and larger pipe, slight changes in direction may be accomplished by axial deflection of the pipe joint. The maximum deflection allowed at each joint is one degree. For changes in direction greater than one degree per joint, fittings shall be used.

7-11.3(5) Cleaning and Assembling Joint

All parts of the pipe ends, couplings, fittings, and appurtenances shall be cleaned to remove oil, grit, or other foreign matter from the joint. Care shall be taken to keep the joint from contacting the ground.

Pipe not furnished with a depth mark shall be marked before assembly to ensure visual observation of the work.

7-11.3(6) Laying Ductile Iron Pipe With Polyethylene Encasement

Where shown in the Plans, the Contractor shall lay ductile iron pipe with a polyethylene encasement. Pipe and polyethylene encasement shall be installed in accordance with AWWA C105.

7-11.3(7) Laying Steel Pipe

7-11.3(7)A Threaded Steel Pipe 100 Millimeters in Diameter and Smaller

Exposed threads, after jointing, shall be brush-coated with an asphalt coating approved by the Engineer.

7-11.3(7)B Coupled Pipe 100 Millimeters in Diameter and Larger

All component parts of couplings, rings, and bells shall receive a protective coating in the same manner as specified for steel pipe. Bolts and nuts, exposed edges, and flanges shall, after installation, be covered with a heavy hot pour of asphalt if asphalt-coated pipe is used, or with coal tar enamel if coal tar-coated pipe is used.

All steel pipe 100 millimeters and larger for above-ground service shall be coupled with flanges, compression type or grooved type couplings.

Pipe for outdoor service above ground shall be protected with one coat of approved primer and one coat of coal tar paint or other coating approved by the Engineer.

Pipe for outdoor service shall be protected with one coat of approved primer and two coats of approved enamel paint or coating of a color specified by the Engineer.

7-11.3(8) Vacant

7-11.3(9) Connections

7-11.3(9)A Connections to Existing Mains

Connections to the existing water main shall not be made without first making the necessary arrangements with the Engineer in advance. Work shall not be started until all the materials, equipment, and labor necessary to properly complete the work are assembled on the site.

Existing water mains shall be cut by the Contractor. The Contractor shall remove the portions of pipe to provide for the installation of the required fittings at the points of connection. All damage caused by the Contractor's operations to existing joints in piping to remain in-service shall be repaired by the Contractor at no expense to the Contracting Agency. The Contractor shall determine the exact length of the existing water main that must be removed. The pipe ends shall be beveled to prevent damage to the transition coupling gasket during installation of the coupling. The exterior of the existing pipe end shall be cleaned to a sound, smooth finish before installation of the coupling.

Transition couplings shall be installed by the Contractor and shall be provided with a plastic film wrap. The plastic film wrap shall be wrapped loosely around the pipe, fittings, and couplings, and secured with 50-millimeter-wide polyethylene adhesive tape. Pipelines in which the couplings are installed shall be wrapped a minimum of 1 meter on each side of the coupling. Joints or seams in the plastic film wrap shall be made using the 50-millimeter-wide polyethylene adhesive tape. The plastic film wrap need not be water-tight, but no part of the pipe or coupling shall be exposed to the backfill. Care shall be exercised during backfilling to prevent the plastic film wrap from being punctured or otherwise damaged. Plastic film wrap and its installation shall conform to AWWA C105 except as modified herein.

When work is once started on a connection, it shall proceed continuously without interruption, and as rapidly as possible until completed. No shutoff of mains will be permitted overnight, over weekends, or on holidays.

If the connection to the existing system involves turning off the water, the Contractor shall be responsible for notifying the residents affected by the shutoff. The Engineer will advise which property owners are to be notified.

The Contractor may be required to perform the connection during times other than normal working hours. The Contractor shall not operate any valves on the existing system without specific permission of the Engineer.

The types of connections are varied and suggested piping arrangements have been shown in the Plans. For the installation of these connections, the surfaced portion of the roadway shall not be penetrated unless the connecting point is directly under it. For connection by any other method, the Contractor shall furnish a detailed sketch for approval not less than two weeks prior to the expected construction.

7-11.3(9)B Maintaining Service

Where existing services are to be transferred from old to new mains, the Contractor shall plan and coordinate its work with that of the Utility so that service will be resumed with the least possible inconvenience to customers.

To supply customers with water during the construction of a water main project where any Section of the pipe has passed satisfactory hydrostatic and bacteriological tests, the Utility reserves the right to tap corporation cocks into the Section of new pipe and install service connections at such locations as the Utility may elect. The installation of any such service connections by the Utility shall not be construed by the Contractor as an acceptance by the Contracting Agency of any part of the work required under the Contract.

7-11.3(10) Detectable Marking Tape

Detectable marking tape shall be installed over all nonmetallic water lines including services lines. The tape shall be placed approximately 0.3 meter above the top of the line and shall extend its full length. Detectable marking tape shall meet the requirements of Section 9-15.18.

7-11.3(11) Hydrostatic Pressure Test

All water mains and appurtenances shall be tested in sections of convenient length under a hydrostatic pressure equal to 1 megapascal in excess of that under which they will operate or in no case shall the test pressure be less than 1.4 megapascals. All pumps, gauges, plugs, saddles, corporation stops, miscellaneous hose and piping, and measuring equipment necessary for performing the test shall be furnished and operated by the Contractor.

The pipeline shall be backfilled sufficiently to prevent movement of the pipe under pressure. All thrust blocks shall be in place and time allowed for the concrete to cure before testing. Where permanent blocking is not required, the Contractor shall furnish and install temporary blocking and remove it after testing.

The mains shall be filled with water and allowed to stand under pressure a sufficient length of time to allow the escape of air and allow the lining of the pipe to absorb water. The Contracting Agency will furnish the water necessary to fill the pipelines for testing purposes at a time of day when sufficient quantities of water are available for normal system operation.

The test shall be accomplished by pumping the main up to the required pressure, stopping the pump for 15 minutes, and then pumping the main up to the test pressure again. During the test, the Section being tested shall be observed to detect any visible leakage.

A clean container shall be used for holding water for pumping up pressure on the main being tested. This makeup water shall be sterilized by the addition of chlorine to a concentration of 50 mg/l.

The quantity of water required to restore the pressure shall be accurately determined by pumping through a positive displacement water meter. The meter shall be approved by the Engineer.

Acceptability of the test will be determined as follows:

The quantity of water lost from the main shall not exceed the number of liters per hour as determined by the formula:

$$L = \frac{ND\sqrt{P}}{4123}$$

in which

L	=	allowable leakage, liters/hour
N	=	number of joints in the length of pipeline tested
D	=	nominal diameter of the pipe in millimeters
P	=	average test pressure during the leakage test, megapascals

There shall not be an appreciable or abrupt loss in pressure during the 15 minute test period.

Gauges used in the test shall be accompanied with certifications of accuracy from a laboratory approved by the Engineer.

Any visible leakage detected shall be corrected by the Contractor regardless of the allowable leakage specified above. Should the tested section fail to meet the pressure test successfully as specified, the Contractor shall, at no expense to the Contracting Agency, locate and repair the defects and then retest the pipeline.

All tests shall be made with the hydrant auxiliary gate valves open and pressure against the hydrant valve. After the test has been completed, each gate valve shall be tested by closing each in turn and relieving the pressure beyond. This test of the gate valve will be acceptable if there is no immediate loss of pressure on the gauge when the pressure comes against the valve being checked. The Contractor shall verify that the pressure differential across the valve does not exceed the rated working pressure of the valve.

Sections to be tested shall normally be limited to 450 meters. The Engineer may require that the first Section of pipe, not less than 300 meters in length, installed by each of the Contractor's crews, be tested in order to qualify the crew and the material. Pipe laying shall not be continued more than an additional 300 meters until the first Section has been tested successfully.

Prior to calling out the Engineer to witness the pressure test, the Contractor shall have all equipment set up completely ready for operation and shall have successfully performed the test to ensure that the pipe is in a satisfactory condition.

Defective materials or workmanship, discovered as a result of hydrostatic field test, shall be replaced by the Contractor at no expense to the Contracting Agency. Whenever it is necessary to replace defective material or correct the workmanship, the hydrostatic test shall be re-run at the Contractor's expense until a satisfactory test is obtained.

7-11.3(11)A Testing Extensions From Existing Mains

When an existing water main is extended with new pipe to a new valve and the distance from the existing pipe to the new valve is 5.5 meters or less, the Section of new pipe installed between the new valve and the end of the existing main shall be made with pretested, prechlorinated pipe, and no hydrostatic test will be required. When the required hydrostatic tests are conducted in the new main Section beyond the installed new valve in the closed position, the normal pressure of the existing main may be present against the other side of the new valve.

Where the distance between the end of an existing water main pipe extension to the new valve is more than 5.5 meters, the connection of the new pipe to existing pipe shall not be made until after hydrostatic tests have been made to the required pressure in both directions against the new valve. This shall be accomplished by a temporary cap or plug installed on the end of the new pipe, beyond the new valve, as close as possible to the existing pipe for testing purposes.

The short length of pipe between the temporary cap or plug end with the new valve in the closed position, with no hydrostatic pressure active on the opposite side of the valve, shall be subjected to the required test pressure. The same test shall be made against the other side of the new valve when that Section of pipe is tested with no hydrostatic pressure active in the short Section of pipe toward the existing main. The final connection to the existing main shall be made with pretested prechlorinated pipe.

7-11.3(11)B Testing Section With Hydrants Installed

When hydrants are included with the Section of main pipe to be tested, the testing shall be conducted in three separate tests as follows:

Test No. 1 — Water main gate valves and hydrant auxiliary gate valves closed, with the hydrant operating stem valves and hose ports wide open.

Test No. 2 — Water main gate valves and the hydrant operating the stem valves tightly closed but the hydrant auxiliary gate valves and hose ports wide open.

Test No. 3 — Each hydrant shall be tested to the pressure indicated in Section 7-11.3(11) with the hydrant auxiliary gate valve and hose ports closed and the hydrant operating stem valve wide open. 175 kilopascals shall be in the supply main beyond the hydrant auxiliary gate valve when testing a hydrant singly.

7-11.3(11)C Testing Hydrants Installed on Existing Mains

For hydrants installed and connected to an existing main, the hydrant connection including hydrant tee, connection pipe, and auxiliary gate valves, shall be installed with pretested materials.

Before the hydrant connection is made to the existing main, the hydrant installation shall be subjected to the hydrostatic Test No. 3 as specified in Section 7-11.3(11)B. Hydrants installed and connected to an existing main shall have a satisfactory bacteriological sample obtained following the hydrostatic test.

7-11.3(12) Disinfection of Water Mains

Before being placed in service, all new water mains and repaired portions of, or extensions to, existing mains shall be chlorinated and a satisfactory bacteriological report obtained.

7-11.3(12)A Flushing

Sections of pipe to be disinfected shall first be flushed to remove any solids or contaminated material that may have become lodged in the pipe. If no hydrant is installed at the end of the main, then a tap shall be provided large enough to develop a velocity of at least 0.75 meters per second in the main.

Taps required by the Contractor for temporary or permanent release of air, chlorination or flushing purposes shall be provided by the Contractor as a part of the construction of water mains.

Where dry calcium hypochlorite is used for disinfection of the pipe, flushing shall be done after disinfection.

The Contractor shall be responsible for disposal of treated water flushed from mains and shall neutralize the waste water for protection of aquatic life in the receiving water before disposal into any natural drainage channel. The Contractor shall be responsible for disposing of disinfecting solution to the satisfaction of Contracting Agency and local authorities. If approved by the Engineer, disposal may be made to any available sanitary sewer provided the rate of disposal will not overload the sewer.

7-11.3(12)B Requirement of Chlorine

Before being placed into service, all new mains and repaired portions of, or extensions to, existing mains shall be chlorinated so that a chlorine residual of not less than 25 mg/1 remains in the water after standing 24 hours in the pipe. The initial chlorine content of the water shall be not less than 50 mg/l.

7-11.3(12)C Form of Applied Chlorine

Chlorine shall be applied by one of the methods which follow, to give a dosage of not less than 50 mg/l of available chlorine.

7-11.3(12)D Dry Calcium Hypochlorite

As each length of pipe is laid, sufficient high test calcium hypochlorite (65-70% chlorine) shall be placed in the pipe to yield a dosage of not less than 50 mg/l available chlorine, calculated on the volume of the water which the pipe and appurtenances will contain.

The number of grams of 65% test calcium hypochlorite required for a 6-meter length of pipe equals

$$0.0003705 \times d^2,$$

in which “d” is the diameter in millimeters.

7-11.3(12)E Liquid Chlorine

A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device, or the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas, or the gas itself, must provide means for preventing the backflow of water into the chlorine.

7-11.3(12)F Chlorine-Bearing Compounds in Water

A mixture of water and high-test calcium hypochlorite (65-70% Cl) may be substituted for the chlorine gas-water mixture. The dry powder shall first be mixed as a paste and then thinned to a 1 percent chlorine solution by adding water to give a total quantity of 62.5 liters of water per kilogram of dry powder. This solution shall be injected in one end of the Section of main to be disinfected while filling the main with water.

7-11.3(12)G Sodium Hypochlorite

Sodium hypochlorite, commercial grade (12.5% Cl) or in the form of liquid household bleach (5-6% Cl), may be substituted for the chlorine gas-water mixture. This liquid chlorine compound may be used full strength or diluted with water and injected into the main in correct proportion to the fill water so that dosage applied to the water will be at least 50 mg/l.

7-11.3(12)H Point of Application

The preferred point of application of the chlorinating agent is at the beginning of the pipeline extension or any valved section of it, and through a corporation stop inserted in the horizontal axis of the pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension. Alternate points of applications may be used when approved by the Engineer.

7-11.3(12)I Rate of Application

Water from the existing distribution system, or other source of supply, shall be controlled to flow very slowly into the newly-laid pipeline during application of the chlorine. The rate of chlorine gas-water mixture or dry gas feed shall be in such proportion to the rate of water entering the newly-laid pipe that the dosage applied to the water will be at least 50 mg/l.

7-11.3(12)J Preventing Reverse Flow

No connections shall be made between the existing distribution system and pipelines not disinfected that are constructed under this Contract without a State Department of Health approved backflow preventer installed in the connecting line.

7-11.3(12)K Retention Period

Treated water shall be retained in the pipe at least 24 hours. After this period, the chlorine residual at pipe extremities and at other representative points shall be at least 25 mg/l.

7-11.3(12)L Chlorinating Valves, Hydrants, and Appurtenances

In the process of chlorinating newly-laid pipe, all valves, hydrants, and other appurtenances shall be operated while the pipeline is filled with the chlorinating agent and under normal operating pressure.

7-11.3(12)M Chlorinating Connections to Existing Water Mains and Water Service Connections

The chlorinating procedure to be followed shall be as specified in Section 9 of AWWA Standard C651. All closure fittings shall be swabbed with a very strong chlorine solution at least as strong as liquid household bleach (5-6% Cl).

7-11.3(12)N Final Flushing and Testing

Following chlorination, all treated water shall be flushed from the newly-laid pipe until the replacement water throughout its length shows, upon test, the absence of chlorine. In the event chlorine is normally used in the source of supply, then the tests shall show a residual not in excess of that carried in the system.

A sample tap shall be located ahead of the flushing hose for convenience and for sanitary sampling.

Before placing the lines into service, a satisfactory report shall be received from the local or State health department on samples collected from representative points in the new system. Samples will be collected and bacteriological tests obtained by the Engineer.

7-11.3(12)O Repetition of Flushing and Testing

Should the initial treatment result in an unsatisfactory bacteriological test, the original chlorination procedure shall be repeated by the Contractor until satisfactory results are obtained. Failure to get a satisfactory test shall be considered as failure of the Contractor to keep the pipe clean during construction, or to properly chlorinate the main.

7-11.3(13) Concrete Thrust Blocking

Concrete thrust blocking, as detailed in the Plans, shall be placed at bends, tees, dead ends, and crosses. Blocking shall be commercial concrete poured in place.

Concrete blocking shall bear against solid undisturbed earth at the sides and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints of the pipe or fittings.

7-11.3(14) Blowoff Assemblies

Blowoff assemblies shall be constructed at the locations shown in the Plans and in accordance with the Standard Plans.

7-11.4 Measurement

Measurement for payment of pipe for water mains will be by the meter of pipe laid and tested and shall be along the pipe through fittings, valves, and couplings.

Measurement for payment of blowoff assembly will be per each.

7-11.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"____ Pipe for Water Main ____ mm Diam.", per meter.

The unit contract price per meter for each size and kind of "____ Pipe for Water Main ____ mm Diam." shall be full pay for all work to complete the installation of the water main including but not limited to trench excavating, bedding, laying and jointing pipe and fittings, backfilling, concrete thrust blocking, testing, flushing, disinfecting the pipeline, and cleanup.

Payment for restoration will be made under the applicable items shown in the Proposal. If no pay items for restoration are included in the Proposal, restoration shall be considered incidental to the work of constructing the water main, and all costs thereof shall be included in the unit contract price bid for "____ Pipe for Water Main ____ mm Diam."

"Blowoff Assembly", per each.

The unit contract price bid per each for "Blowoff Assembly" shall be full pay for all work to install the blowoff assembly, including but not limited to excavating, backfilling, laying and jointing pipe, tapping the main, corporation stop, pipe and fittings, gate valve, meter box, and cover and cleanup.

7-12 VALVES FOR WATER MAINS

7-12.1 Description

Valves for water mains shall be suitable for ordinary waterworks service, intended to be installed in a normal position on buried pipelines for water distribution systems.

Valves shall open counterclockwise and shall be equipped with a 50-millimeter-square AWWA standard operating nut. Unless otherwise specified, all valves shall be the nonrising stem type.

7-12.2 Materials

Materials shall meet the requirements of the following sections:

Gate Valves (75 mm to 300 mm)	9-30.3(1)
Gate Valves (350 mm and 400 mm)	9-30.3(2)
Butterfly Valves	9-30.3(3)
Valve Boxes	9-30.3(4)
Valve Marker Posts	9-30.3(5)
Combination Air Release/Air Vacuum Valves	9-30.3(7)
End Connections	9-30.5(1)
Tapping Sleeve and Valve Assembly	9-30.3(8)

The valves shall be standard pattern of a manufacturer whose products are approved by the Engineer and shall have the name or mark of the manufacturer, year valve casting was made, size and working pressure plainly cast in raised letters on the valve body.

The valve bodies shall be cast iron, ductile iron, or other approved material mounted with approved noncorrosive metals. All wearing surfaces shall be bronze or other approved noncorrosive material, and there shall be no moving bearing or contact surfaces of iron in contact with iron. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable.

7-12.3 Construction Requirements

All valves shall be inspected upon delivery in the field to ensure proper working order before installation. They shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connecting ends furnished. The valves shall also be carefully inspected for injury to the outer protective coatings. At all places where the coating has been ruptured or scraped off, the damaged area shall be cleaned to expose the iron base installation, and the cleaned area shall then be recoated with two or more field coats of approved protective coating.

Upon delivery at the work site, all valves shall be opened to prevent the collection of water in the valve. Valves shall have the interiors cleaned of all foreign matter and shall be inspected both in open and closed position prior to installation. Valves and valve boxes shall be set plumb and valve boxes shall be placed over the valve or valve operator in a manner that the valve box does not transmit shock or stress to the valve. The lower casting of the unit is installed first, in a manner as to be supported by a minimum backfill or by a Styrofoam collar not less than 50 millimeters in thickness. The casting shall not rest directly upon the body of the valve or upon the water main. Backfill shall be carefully tamped around the valve box to a distance of 1 meter on all sides or to the undisturbed face of the trench if it is closer. The cast iron valve box cover shall be set flush with the roadbed or finished paved surface.

The combination air release/air vacuum valves shall be installed as shown in the Plans. All piping shall be sloped to permit escape of any entrapped air. Backfilling and compaction shall be as specified in Section 7-10.

After installation, all valves shall be subjected to field testing and disinfected as outlined in Section 7-11. Should any defects in design, materials, or workmanship appear during these tests, the Contractor shall correct such defects with the least possible delay and to the satisfaction of the Engineer.

7-12.3(1) Installation of Valve Marker Post

Where required, a valve marker post shall be furnished and installed with each valve. Valve marker posts shall be placed at the edge of the right-of-way opposite the valve and be set with 450 millimeters of the post exposed above grade. The exposed portion of the valve marker posts shall be painted with two coats of concrete paint in a color selected by the Engineer, and then the size of the valve and the distance in meters to the valve shall be stenciled with black paint on the face of the post, using a stencil which will produce letters 50 millimeters high.

7-12.4 Measurement

Measurement of valves shall be per each for each type and size actually installed.

7-12.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Gate Valve ____ mm", per each

"Butterfly Valve ____ mm", per each

"Comb. Air Release/Air Vacuum Valve Assembly ____ mm", per each

"Tapping Sleeve and Valve Assembly ____ mm", per each

The unit contract price per each for the valve specified shall be full pay for all work to furnish and install the valve complete in place on the water main, including trenching, jointing, blocking of valve, painting, disinfecting, hydrostatic testing, valve box, and marker post.

7-14 HYDRANTS

7-14.1 Description

This Section covers the installation of dry-barrel fire hydrants intended for ordinary water works service.

7-14.2 Materials

Materials shall meet the requirements of the following sections:

Hydrants	9-30.5
End Connections	9-30.5(1)
Hydrant Dimensions	9-30.5(2)
Hydrant Extensions	9-30.5(3)
Hydrant Restraint	9-30.5(4)
Traffic Flange	9-30.5(5)
Guard Posts	9-30.5(6)

7-14.3 Construction Requirements

7-14.3(1) Setting Hydrants

Where shown in the Plans, hydrants shall be installed in accordance with the Standard Plans. In addition, a minimum 1-meter radius unobstructed working area shall be provided around all hydrants. The sidewalk flange shall be set 50 millimeters above finished grade.

All hydrants shall be set on concrete blocks as shown in the Standard Plans. The hydrant barrel drain shall waste into a pit of porous gravel material situated at the base of the hydrant as shown in the Standard Plans.

All hydrants shall be inspected upon delivery in the field to ensure proper working order. After installation, fire hydrants, auxiliary gate valves, and other appurtenances thereto shall be subjected to a hydrostatic test and disinfection procedures as specified in Section 7-11.

After all installation and testing is complete, the exposed portion of the hydrant shall be painted with one field coat. The type and color of paint will be designated by the Engineer.

Any hydrant not in service shall be identified by covering with a burlap or plastic bag properly secured.

7-14.3(2) Hydrant Connections

Hydrant laterals shall consist of one continuous section of 150-millimeter ductile iron pipe from the main to the hydrant and shall include an auxiliary gate valve set vertically and placed in accordance with the Standard Plan.

7-14.3(2)A Hydrant Restraints

The thrust created in the hydrant lateral shall be restrained as shown in the Standard Plans. If applicable, shackle rods, after installation, shall be cleaned and painted with two coats of asphalt varnish, or with such other bituminous coating as may be approved by the Engineer.

7-14.3(2)B Auxiliary Gate Valves and Valve Boxes

Auxiliary gate valves and valve boxes shall be installed in accordance with Section 7-12 except that the end connections shall be provided with lugs for shackling, or the bells shall provide sufficient clearance between the body of the valve and the hub to permit the installation of shackles.

7-14.3(2)C Hydrant Guard Posts

Hydrant guard posts shall be constructed at the locations shown in the Plans. The exposed portion of each guard post shall be painted with one coating of the type and color designated by the Engineer.

7-14.3(3) Resetting Existing Hydrants

Where existing hydrants are shown in the Plans for adjustments to conform to a new street alignment or grade or both, the hydrant shall be relocated without disturbing the location of the hydrant lateral tee at the main.

The method for thrust restraint for the hydrant lateral shall be determined by the conditions found in the field and shall be constructed as directed by the Engineer.

This work shall conform to Section 7-14.3(1).

7-14.3(4) Moving Existing Hydrants

Existing hydrants shall be moved where shown in the Plans. When the existing hydrant lateral tee does not accommodate a new hydrant location, a new hydrant lateral tee shall be installed in the main. The existing hydrant lateral tee shall be removed from the main (if said main is to remain active), and a new section of pipe inserted into the water main in place of the existing hydrant lateral tee. Where the existing main to which the existing hydrant lateral tee is connected, and is to be abandoned or temporarily activated after the existing hydrant is moved, the open end of the hydrant lateral pipeline shall be plugged (and temporary thrust restrain provided if temporarily reactivated). All work shall meet the requirements of Section 7-14.3(1).

7-14.3(5) Reconnecting Existing Hydrants

Existing hydrants shall be reconnected where shown in the Plans. The location and elevation of the existing hydrant shall remain unchanged, but the existing hydrant connection is changed to connect with a new hydrant tee provided in a new main.

Where existing hydrants were not shackled to the old main, the new connection shall be shackled with steel rods as shown in the Standard Plans, or by such other shackling method as may be directed by the Engineer.

Hydrant reconnections shall meet the requirements of Sections 7-14.3(1) and 7-14.3(2).

7-14.3(6) Hydrant Extensions

The Contractor shall furnish and install hydrant extensions where required. The hydrant extensions, operating stems for the hydrant main valves, and sidewalk flanges shall conform to AWWA C502. After installation, the extended fire hydrant shall be subjected to a hydrostatic pressure test and disinfection procedure as specified in Section 7-11.

7-14.4 Measurement

Measurement of hydrant assembly, resetting existing hydrants, moving existing hydrants, and reconnecting existing hydrants will be made per each. Measurement of hydrant extension will be made per meter.

7-14.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Hydrant Assembly", per each.

The unit contract price per each for "Hydrant Assembly" shall be full pay for all work to furnish and install fire hydrant assemblies, including all costs for auxiliary gate valve, shackles, tie rods, concrete blocks, gravel, and painting required for the complete installation of the hydrant assembly as specified, except the pipe connecting the hydrant to the main and the hydrant lateral tee will be paid for as specified in Section 7-11.5.

"Resetting Existing Hydrants", per each.

The unit contract price per each for "Resetting Existing Hydrant" shall be full pay for all work to reset the existing hydrant, including shackling, painting, and reconnecting to the main. New pipe required from the main to the hydrant will be paid as specified in Section 7-11.5.

"Moving Existing Hydrants", per each.

The unit contract price per each for "Moving Existing Hydrant" shall be full pay for all work to move the existing hydrant, including new hydrant lateral tee, shackling, painting, and reconnecting to the main. New pipe for hydrant connections will be paid for as specified in Section 7-11.5.

"Reconnecting Existing Hydrants", per each.

The unit contract price per each for "Reconnecting Existing Hydrant" shall be full pay for all work to reconnect the existing hydrant, excepting however, that new pipe used for the connection will be paid as specified in Section 7-11.5.

"Hydrant Extensions", per meter.

The unit contract price per meter for "Hydrant Extension" shall be full pay for all work to extend the hydrant vertically.

7-15 SERVICE CONNECTIONS

7-15.1 General

This work consists of installing the service connections from the main to the water meter for the premises served. Service connections for commercial premises as well as residential premises are included.

7-15.2 Materials

Materials shall meet the requirements of the following sections:

Saddles	9-30.6(1)
Corporation Stops	9-30.6(2)
Service Pipe	9-30.6(3)
Service Fittings	9-30.6(4)
Meter Setters	9-30.6(5)
Bronze Nipples and Fittings	9-30.6(6)
Meter Boxes	9-30.6(7)

7-15.3 Construction Requirements

All service connections to water mains, except to ductile iron pipe Class 52 or stronger, shall be made using saddles as specified and be of the size and type suitable for use with the pipe being installed. Ductile iron pipe Class 52 or stronger may be direct tapped for corporation stops in accordance with the recommendations of DIPRA; unless direct taps are prohibited by the Special Provisions. Service pipelines shall be installed perpendicular to the main, unless shown otherwise in the Plans.

The depth of trenching for service connection piping shall provide a minimum of 0.9 meter of cover over the top of the pipe. Particular care shall be exercised to ensure that the main is not damaged by the work undertaken to install the service. Excavating and backfilling for service connections shall be as specified in Section 7-10, except that the service pipeline shall be installed under pavement, curbs, and sidewalks by boring methods approved by the governmental agency having jurisdiction over the roadway.

Service pipes shall be cut using a tool or tools specifically designed to leave a smooth, even, and square end on the piping material to be cut. Cut ends shall be reamed to the full inside diameter of the pipe. Pipe ends to be connected using couplings which seal to the outside surface of the pipe shall be cleaned to a sound, smooth finish before the couplings are installed. The meter box shall be adjusted to the finished grade after the surface has been acceptably restored.

Where shown in the Plans, existing service connections shall be reconnected to the new mains. The location of existing service connections shall be verified in the field by the Contractor. The Contractor shall notify affected customers of the service interruption at least 24 hours prior to service interruption.

Pipe materials used to extend or replace existing service connections beyond the meter box shall be copper or polyethylene pipe. Insulating couplings shall be used at any connection between galvanized steel or iron pipe and copper pipe. All fittings, appurtenances, and other miscellaneous materials on the sections of existing pipe which have been removed shall become the property of the Contractor.

7-15.3(1) Flushing and Disinfection

All service pipe and appurtenances shall be prechlorinated prior to installation. After installation, the service connection shall be flushed prior to connecting the meter.

7-15.4 Measurement

Service connections will be measured per each for each size of service connection installed.

7-15.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Service Connection ____ mm Diam.", per each.

The unit contract price per each for "Service Connection ____ mm Diam." shall be full pay for all work to install the service connection, including but not limited to, excavating, tapping the main, laying and jointing the pipe and fittings and appurtenances, backfilling, testing, flushing, and disinfection of the service connection.

7-17 SANITARY SEWERS

7-17.1 Description

This work shall consist of constructing sanitary sewer lines in accordance with the Plans, these Specifications, and the Standard Plans, as staked.

7-17.2 Materials

Pipe used for sanitary sewers may be:

Rigid	Thermoplastic
Concrete	ABS Composite
Vitrified Clay	PVC (Polyvinyl Chloride)
Ductile Iron	

All sanitary sewer pipe shall have flexible gasketed joints unless otherwise specified.

It is not intended that materials listed are to be considered equal or generally interchangeable for all applications. The Engineer shall determine from the materials listed those suitable for the project, and shall so specify in the specifications or the Plans.

Materials shall meet the requirements of the following sections.

Plain Concrete Storm Sewer Pipe	9-05.7(1)
Reinforced Concrete Storm Sewer Pipe	9-05.7(2)
Vitrified Clay Sewer Pipe	9-05.8
Solid Wall PVC Sanitary Sewer Pipe	9-05.12(1)
Profile Wall PVC Sanitary Sewer Pipe	9-05.12(2)
Ductile Iron Sewer Pipe	9-05.13
ABS Composite Sewer Pipe	9-05.14

All pipe shall be clearly marked with type, class, and thickness. Lettering shall be legible and permanent under normal conditions of handling and storage.

7-17.3 Construction Requirements

Sanitary sewers shall be constructed in accordance with Section 7-08.3.

7-17.3(1) Protection of Existing Sewerage Facilities

All existing live sewers including septic tanks and drain fields shall be kept in service at all times. Provision shall be made for disposal of sewage flow if any existing sewers are damaged. Damage to existing sewers shall be repaired by the Contractor, at no expense to the Contracting Agency, to a condition equal to or better than their condition prior to the damage.

Water accumulating during construction shall be removed from the new sewers but shall not be permitted to enter the existing system. The Contractor shall be responsible for flushing out and cleaning any existing sewers into which gravel, rocks, or other debris has entered as a result of their operations, and shall repair lift stations or other facilities damaged by the Contractor's operations.

The physical connection to an existing manhole or sewer shall not be made until authorized by the Engineer. Such authorization will not be given until all upstream lines have been completely cleaned, all debris removed, and where applicable, a pipe temporarily placed in the existing channel and sealed.

7-17.3(2) Cleaning and Testing

7-17.3(2)A General

Sewers and appurtenances, where required in the Plans, shall be cleaned and tested after backfilling by either the exfiltration or low pressure air method at the option of the Contractor, except where the ground water table is such that the Engineer may require the infiltration test.

All work involved in cleaning and testing sewer lines between manholes or rodding inlets as required shall be completed within fifteen working days after backfilling of sewer lines and structures. Any further delay will require the written consent of the Engineer. The Contractor shall furnish all labor, materials, tools, and equipment necessary to make the test, clean the lines, and perform all incidental work. The Contractor shall perform the tests under the direction and in the presence of the Engineer. Precautions shall be taken to prevent joints from drawing during tests, and any damage resulting from these tests shall be repaired by the Contractor at no expense to the Contracting Agency. The manner and time of testing shall be subject to approval by the Engineer.

All wyes, tees, and stubs shall be plugged with flexible jointed caps, or acceptable alternate, securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.

Testing side sanitary sewers shall be for their entire length from the public sewer in the street to the connection with the building's plumbing. Their testing shall be as required by the local sanitary agency but in no case shall it be less thorough than that of filling the pipe with water before backfilling and visually inspecting the exterior for leakage. The decision of the Engineer as to acceptance of the side sanitary sewer shall be final.

If any sewer installation fails to meet the requirements of the test method used, the Contractor shall determine, at no expense to the Contracting Agency, the source or sources of leakage and shall repair or replace all defective materials or workmanship at no expense to the Contracting Agency. The complete pipe installation shall meet the requirements of the test method used before being considered acceptable.

7-17.3(2)B Exfiltration Test

Prior to making exfiltration leakage tests, the Contractor may fill the pipe with clear water to permit normal absorption into the pipe walls provided, however, that after so filling the pipe the Contractor shall complete the leakage test within 24 hours after filling. When under test, the allowable leakage shall be limited according to the provisions that follow. Specified allowances assume pre-wetted pipe.

Leakage shall be no more than 1.4 liters per hour per meter diameter per meter of sewer, with a hydrostatic head of 2 meters above the crown at the upper end of the test section, or above the natural ground water table at the time of test, whichever is higher. The length of pipe tested shall be limited so that the pressure at the lower end of the Section tested does not exceed 4.9 meters of head above the invert, and in no case shall be greater than 200 meters or the distance between manholes when greater than 200 meters.

Where the test head is other than 2 meters, the maximum leakage shall not exceed 1 liter per hour per meter of diameter per meter of pipe length times the square root of the test head. The leakage can be determined from the equation:

Maximum leakage (in liters per hour) = $1.0 \times D \times L \times \sqrt{H}$

where: D = diameter (meters)
L = length of pipe (meters)
H = test head (meters)

When the test is to be made one joint at a time, the leakage per joint shall not exceed the computed allowable leakage per length of pipe.

7-17.3(2)C Infiltration Test

Where the natural ground water head over the pipe is 0.5 meters or less above the crown of pipe at the upper end of the test section, the infiltration test leakage shall not exceed 1 liter per hour per meter of diameter per meter of pipe length. The length of pipe tested shall not exceed 200 meters or the distance between manholes when greater than 200 meters.

Where the natural ground water head is greater than 0.5 meters, the maximum leakage shall not exceed 1 liter per hour per meter of diameter per meter of pipe length times the square root of the natural ground water head. The leakage can be determined from the equation:

Maximum leakage (in liters per hour) = $1.0 \times D \times L \times \sqrt{H}$

where: D = diameter (meters)
L = length of pipe (meters)
H = natural ground water head (meters)

When a suitable head of ground water exists above the crown of the pipe and when the pipe is large enough to work inside, acceptance may be based on the repair of visible leakage by means satisfactory to the Engineer.

7-17.3(2)D Other Test Allowances

For either the infiltration or exfiltration test, all lateral or side sewer branches included in the test section shall be taken into account in computing allowable leakage. An allowance of 2.5 liters per hour per meter of head above invert shall be made for each manhole included in a test section.

Upon final acceptance of the work all sewers, side sewers and fittings shall be open, clean, and free draining.

7-17.3(2)E Low Pressure Air Test For Sanitary Sewers Constructed of Air-Permeable Materials

Air permeable materials include concrete and vitrified clay. Low pressure air testing may be used for air-permeable pipes 750 millimeters in diameter and smaller.

The test equipment to be used shall be furnished by the Contractor and shall be inspected and approved by the Engineer prior to use. The Engineer may at any time require a calibration test of gauges or other instrumentation that is incorporated into the test equipment. Calibration tests shall be certified by an independent testing laboratory.

Plugs used to close the pipe for the air test must be securely braced to prevent the unintentional release of a plug which can become a high velocity projectile. Gauges, air piping manifold, and valves shall be located at the top of the ground. No one shall be permitted to enter a manhole or catch basin where a plugged pipe is under pressure. Air testing apparatus shall be equipped with a pressure release device, such as a rupture disk or a pressure relief valve, designed to activate when the pressure in the pipe exceeds 14 kPa gauge above the required test pressure.

If the pipe to be tested is submerged by groundwater, the back pressure on the pipe created by the groundwater submergence must be determined. All gauge pressures described in the test shall be increased by that amount.

The first section of pipe installed by each crew shall be tested in order to qualify the crew and material. A successful test for the section shall be a prerequisite to further installation by that crew. Following the initial test, pipes shall be tested from manhole to manhole, catch basin to catch basin, or such shorter lengths as determined by the Contractor.

Air shall be slowly supplied to the plugged pipe section until the internal air pressure reaches 27 kPa gauge. Wait at least two minutes to allow for pressure and temperature stabilization to occur within the pipe.

When the pressure decreases to 24 kPa gauge, the air pressure test shall begin. The test shall consist of measuring the time in seconds for the pressure in the pipe to drop from 24 kPa gauge to 17 kPa gauge. The pipe shall be considered acceptable if the time in seconds for the pressure drop is equal to or greater than the required time as calculated below:

$$K = 5.83 \times 10^{-5} d^2 L$$
$$C = 5.14 \times 10^{-5} dL$$

If	$CT \leq 1$,	then time = KT
If	$1 < CT < 1.75$,	then time = KT/CT
If	$CT \geq 1.75$,	then time = KT/1.75

where:
- d = pipe diameter (mm)
- L = pipe length (m)
- K = value for each length of pipe of a specific diameter
- C = value for each length of pipe of a specific diameter
- KT = sum of all K values
- CT = sum of all C values

This method was developed based on an allowable air loss rate of 0.9 liters per minute per square meter of internal pipe surface, with the total air loss rate not less than 55 liters per minute nor greater than 100 liters per minute. At the Contractor's option, the pipe may be tested without pre-wetting; however, the allowable air loss rate assumes pre-wetted pipe.

Pipe over 750 mm in diameter shall be tested one joint at a time in accordance with ASTM C l103M.

7-17.3(2)F Low Pressure Air Test for Sanitary Sewers Constructed of Non Air-Permeable Materials

Non air-permeable materials include ductile iron, ABS composite, polyvinyl chloride (PVC), and polyethylene (PE). When non air-permeable pipe is subjected to a low pressure air test, all of the previsions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than 4 times the required time calculated in Section 7-17.3(2)E.

Pipe over 750 mm in diameter shall be tested one joint at a time in accordance with ASTM C 1103M.

7-17.3(2)G Deflection Test for Thermoplastic Pipe

Sanitary sewers constructed of thermoplastic pipe shall be tested for deflection not less than 30 days after the trench backfill and compaction has been completed. The test shall be conducted by pulling a properly sized "go-nogo" mandrel through the completed pipeline. Testing shall be conducted on a manhole-to-manhole basis and shall be done after the line has been completely flushed out with water.

The mandrel shall be a rigid, nonadjustable mandrel having an effective length of not less than its normal diameter and an odd-number of legs (9 legs minimum). Minimum diameter at any point along the full length of the mandrel shall be 95 percent of the base inside diameter of the pipe being tested.

Base inside diameter is derived by subtracting a statistical tolerance package from the average inside diameter. The tolerance package is defined as the square root of the sum of squared manufacturing tolerances. The tolerance package for controlled outside diameter pipe consists of (1) outside diameter tolerance specified in applicable ASTM Standard, (2) 12 percent of one wall thickness specified in applicable ASTM Standard, and (3) out of roundness tolerance listed in appendix of applicable ASTM Standard. The items in the tolerance package for controlled inside diameter pipe consists of (1) inside diameter tolerance listed in appendix of applicable ASTM Standard and (2) out of roundness tolerance listed in appendix of applicable ASTM Standard. When out of roundness tolerance is not listed, use 3 percent of average inside diameter.

The average inside diameter for pipe with controlled outside diameter shall be equal to the average outside diameter as specified in applicable ASTM Standard minus two minimum wall thicknesses as specified in applicable ASTM Standard and minus two times excess wall tolerance of 6 percent. The average inside diameter for pipes with controlled inside diameter shall be the average inside diameter as specified in applicable ASTM Standard.

The Contractor shall be required, at no expense to the Contracting Agency, to locate and uncover any sections failing to pass the test and, if not damaged, reinstall the pipe. The use of a vibratory re-rounding device or any process other than removal or reinstallation shall not be acceptable. The Contractor shall retest the section after replacement of the pipe.

Pipe large enough to work inside of may be accepted on the basis of direct measurement.

7-17.3(2)H Television Inspection

The Engineer may require any or all sanitary sewer lines be inspected by the use of a television camera before final acceptance. The costs incurred in making the initial inspection shall be borne by the owner of the sanitary sewer.

The Contractor shall bear all costs incurred in correcting any deficiencies found during television inspection including the cost of any additional television inspection that may be required by the Engineer to verify the correction of said deficiency.

The Contractor shall be responsible for all costs incurred in any television inspection performed solely for the benefit of the Contractor.

7-17.4 Measurement

The length of sewer pipe will be the number of meters of completed installation measured along the invert and will include the length through elbows, tees and fittings. The number of meters will be measured from the center of manhole to center of manhole or to the inside face of catch basins and similar type structures.

The length of testing sewer pipe in conformance with Section 7-17.3(2) will be the number of meters of completed installation actually tested.

7-17.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Plain Conc. or V.C. Sewer Pipe ____ mm Diam.", per meter.

"Cl. ____ Reinf. Conc. Sewer Pipe ____ mm Diam.", per meter.

"PVC Sanitary Sewer Pipe ____ mm Diam.", per meter.

"Ductile Iron Sewer Pipe ____ mm Diam.", per meter.

"ABS Composite Sewer Pipe ____ mm Diam.", per meter.

The unit contract price per meter for sewer pipe of the kind and size specified shall be full pay for furnishing, hauling, and assembling in place the completed installation including all wyes, tees, special fittings, joint materials, bedding and backfill material, and adjustment of inverts to manholes for the completion of the installation to the required lines and grades.

"Testing Sewer Pipe", per meter.

The unit contract price per meter for "Testing Sewer Pipe" shall be full pay for all labor, material and equipment required to conduct the leakage tests required in Section 7-17.3(2).

"Removal and Replacement of Unsuitable Material", per cubic meter.

The unit contract price per cubic meter for "Removal and Replacement of Unsuitable Material" shall be full pay for all work to remove unsuitable material and replace and compact suitable material as specified in Section 7-08.3(1)A.

7-18 SIDE SEWERS

7-18.1 Description

This work shall consist of constructing side sewers in accordance with the Plans, these Specifications, and the Standard Plans, at locations staked, on both the right of way and private property between the main sanitary sewer line and the stubout from a residence or other building.

7-18.2 Materials

Materials shall be the same as required for sanitary sewers in Section 7-17.

7-18.3 Construction Requirements

7-18.3(1) General

The construction requirements for sanitary sewers in Section 7-17 shall apply to the construction of side sewers.

Side sewers shall not be backfilled prior to inspection.

Side sewers shall be constructed with a maximum joint deflection not to exceed the manufacturer's printed recommendations and in no case shall exceed 160 millimeters per meter in any joint. Larger changes in direction shall be made by use of standard 1/8 bends.

7-18.3(2) Fittings

Side sewers shall be connected to the tee, wye, or riser provided in the public sewer, where such is available, utilizing approved fittings or adapters. Where no tee, wye, or riser is provided or available, connection shall be made by machine-made tap and approved saddle.

7-18.3(3) Testing

All side sewers shall be tested after backfilling.

All side sewers constructed in conjunction with the main sewer shall, for purposes of testing as specified in Section 7-17, have a 150-millimeter tee fitting pipe placed at the point where the side sewer crosses the street or other public right of way margin. The tee opening shall be positioned perpendicular to the side sewer slope, unless otherwise directed by the Engineer.

When side sewers are not tested simultaneously with the testing of the main sewer, the Contractor, at no expense to the Contracting Agency, shall furnish and place an additional tee in the first pipe out of the main sewer tee or wye branch, so that an inflatable rubber ball can be inserted for sealing off the side sewer and thus permit separate tests.

7-18.3(4) Extending Side Sewers Into Private Property

Side sewers shall not be constructed on private property prior to completion and acceptance of the main line and side sewer on public right of way or easement unless approved in writing by the Engineer.

7-18.3(5) End Pipe Marker

The location of side sewers at the property line shall be marked by the Contractor with a 2 by 4 wooden stake 1.2 meters long buried in the ground a depth of 1 meter. The low end shall have a 2 by 4 cleat nailed to it to prevent withdrawal of the stake. The exposed end shall be painted traffic white and the depth to the side sewer or tee shall be indicated in black paint on the 2 by 4. In addition, a length of 12 gauge galvanized wire shall be provided to extend from the plugged end of the side sewer or tee. The upper end shall emerge at 1.2 meter stake, but shall not be fastened to it.

7-18.4 Measurement

Measurement shall be as specified in Section 7-17.4.

7-18.5 Payment

Payment shall be made in accordance with Section 1-04.1, for each of the bid items shown in Section 7-17.5 that are included in the proposal.

The unit contract price per meter for sewer pipe of the various kind and size specified shall be full pay for all work required for the completion of the installation including fittings and end pipe marker.

7-19 SEWER CLEANOUTS

7-19.1 Description

This work shall consist of the construction of sanitary sewer cleanouts in accordance with the Plans, these Specifications, and the Standard Plans as staked.

7-19.2 Materials

All materials incorporated into the total cleanout structure shall meet the requirements of the various applicable sections of these Specifications.

7-19.3 Construction Requirements

A cleanout shall be provided for each total change of 90 degrees of grade or alignment and in no case shall the spacing of cleanouts exceed 30 meters. No cleanout will be required at the connection of the side sewer to a riser on the public sewer. A suitably located cleanout in the house piping or plumbing may be considered as a cleanout for the side sewer. Cleanouts shall consist of a wye branch in the side sewer.

All cleanouts located in public rights of way shall be extended to grade.

The extension of cleanouts to grade on private property will be optional with the property owner. When extended to grade, cleanouts shall be full side sewer diameter and shall be extended to a point not less than 150 millimeters nor more than 300 millimeters below the finished ground surface and shall be plugged with a removable stopper which will prevent passage of dirt or water. When specified, the Contractor shall install an approved casting to provide ready access to the cleanout stopper. A 1⁄8-bend shall be used to deflect the side sewer upward as a cleanout where the terminal end of the side sewer lies upstream from the last point of connection.

7-19.4 Measurement

Measurement for cleanouts shall be determined by the count of the actual number installed.

7-19.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when listed in the proposal:

"Sewer Cleanout", per each.

The price bid for cleanouts shall be full pay for furnishing and placing the wye, pipe, pipe bends, pipe plug, castings, and collar as specified herein and as shown on the Standard Plan.

DIVISION 8
MISCELLANEOUS CONSTRUCTION

8-01 EROSION CONTROL

8-01.1 Description

This work shall consist of preparing slopes, placing and compacting topsoil, seeding, fertilizing, and mulching all graded and disturbed areas in accordance with these Specifications and as shown in the Plans or as designated by the Engineer.

8-01.2 Materials

Materials shall meet the requirements of the following sections:

Topsoil, Type A, Type B, and Type C	9-14.1
Seed	9-14.2
Fertilizer	9-14.3
Lime	9-14.3(1)
Mulch and Amendments	9-14.4
Tackifier	9-14.4(7)
Matting	9-14.5
Water for Plants	9-25.2

8-01.3 Construction Requirements

8-01.3(1) Preparation of Area

8-01.3(1)A Cultivation

Areas to be cultivated are shown in the Plans or specified in the Special Provisions. The areas shall be cultivated to the depths specified to provide a reasonably firm but friable seedbed. Cultivation shall take place no sooner than two weeks prior to seeding.

All cost incurred in performing the work specified shall be included in other bid items on the project.

8-01.3(1)B Compaction

In addition to the compaction that may be required elsewhere in the specifications, all areas to be seeded, including excavation slopes, shall be compacted and prepared unless otherwise specified or ordered by the Engineer. Unless seed is covered with soil during seed application, a cleated roller, crawler tractor, or similar equipment, approved by the Engineer, that forms longitudinal depressions at least 50 millimeters deep shall be used for compaction and preparation of the surface to be seeded. The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope unless otherwise approved by the Engineer. The soil shall be conditioned with sufficient water so the longitudinal depressions will remain in the soil surface until completion of the seeding. The area shall be compacted within three weeks prior to seeding. Prior to seeding, the finished grade of the soil shall be 25 millimeters, or the specified depth of mulch, below the top of all curbs, catch basins, junction and valve boxes, walks, driveways, and other structures.

8-01.3(1)C Preparation

All areas to be seeded shall meet the specified finish grades and shall be free of undesirable weed or plant growth and all clods, rocks, and debris 75 millimeters or larger in any dimension.

8-01.3(2) Topsoil

Topsoil shall be evenly spread over the specified areas to the depth shown in the Plans or as otherwise ordered by the Engineer. The soil shall be cultivated to a depth of 300 millimeters or as specified in the Special Provisions or the Plans. After the topsoil has been spread, all large clods, hard lumps, rocks 50 millimeters in diameter and larger, and litter shall be raked up, removed, and disposed of by the Contractor.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Engineer in a condition detrimental to the work.

8-01.3(2)A Topsoil Type A

Topsoil Type A shall be as specified in the Special Provisions.

8-01.3(2)B Topsoil Type B

Topsoil Type B shall be native topsoil taken from within the project limits and shall meet the requirements of Section 9-14.1(2).

Topsoil Type B shall be taken from areas designated by the Engineer to the designated depth and placed at locations which will not interfere with the construction of the project as approved by the Engineer. Areas beyond the slope stakes shall be disturbed as little as possible in the above operations.

When topsoil Type B is specified in the project, it will be the Contractor's responsibility to perform the excavation operations in such a manner that sufficient material is set aside to satisfy the needs of the project.

Upon physical completion of the work, topsoil Type B remaining and not required for use on the project shall be disposed of by the Contractor at no expense to the Contracting Agency and to the satisfaction of the Engineer.

Should a shortage of topsoil Type B occur and the Contractor has wasted or otherwise disposed of topsoil material, the Contractor shall furnish topsoil Type C at no expense to the Contracting Agency.

Topsoil Type B will not be considered as selected material as defined in Section 2-03.3(10), and the conditions of said section shall not apply.

Material taken from roadway excavation, borrow, strippings, or other excavation items and utilized for topsoil will not be deducted from the pay quantities for the respective items.

8-01.3(2)C Topsoil Type C

Topsoil Type C shall be native topsoil obtained from a source provided by the Contractor outside of the Contracting Agency-owned right of way. Topsoil Type C shall meet the requirements of Section 8-01.3(2)B and Section 9-14.1(2).

8-01.3(3) Vacant

8-01.3(4) Seeding and Fertilizing

8-01.3(4)A Seeding

The Contractor shall notify the Engineer not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding of the approved slopes shall begin immediately.

Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable. Seed shall be placed at the rate and mix specified in the Special Provisions or as designated by the Engineer. Seed may be sown by one of the following methods:

1. An approved hydroseeder which utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry.
2. Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed at the rates specified.
3. Helicopters properly equipped for aerial seeding.
4. Approved power-drawn drills or seeders.

When seeding by hand, the seed shall be incorporated into the top 6 millimeters of soil by hand raking or other method that is approved by the Engineer.

Areas in which the above methods are impractical may be seeded by approved hand methods.

Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydroseeder tank no more than 30 minutes prior to application. The seed shall have a tracer added to visibly aid uniform application. This tracer shall not be harmful to plant and animal life. If wood cellulose fiber is used as a tracer, the application rate shall not exceed 300 kilograms per hectare.

Reseeding ordered by the Engineer and not considered the responsibility of the Contractor shall be performed by the Contractor and payment made at unit contract prices for the areas reseeded.

8-01.3(4)B Fertilizing

Fertilizer shall be applied in accordance with the procedures and requirements for seeding in Section 8-01.3(4)A at the rates and analysis specified in the special provisions.

8-01.3(4)C Liming

Agricultural lime shall be applied at the rates specified in the Special Provisions. The method of application shall be in conformance with all air and water pollution regulations and shall be approved by the Engineer.

8-01.3(5) Mulching

Mulch of the type specified in the Special Provisions shall be furnished, hauled, and evenly applied at the rates indicated and shall be spread on seeded areas within 48 hours after seeding unless otherwise specified.

Distribution of straw mulch material shall be by means of an approved type mulch spreader which utilizes forced air to blow mulch material on seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks.

Wood cellulose fiber used as a mulch shall be suitable for application with hydro-seeders as specified in Section 8-01.3(4)A.

Wood cellulose fiber may be applied with seed and fertilizer West of the summit of the Cascade Range and only upon written request by the Contractor and approval of the Engineer East of the summit of the Cascade Range.

Areas not accessible by mulching equipment shall be mulched by approved hand methods.

Mulch sprayed on signs or sign structures shall be removed the same day.

8-01.3(6) Binding Agents

8-01.3(6)A Application of Asphalt Emulsion

When called for in the Special Provisions, mulch shall be anchored in place with asphalt emulsion. Asphalt emulsion may be sprayed into the mulch as it leaves the blower pipe or by other approved methods and shall be uniformly mixed with or cover the mulch. Asphalt emulsion shall be applied at the rate designated by the Engineer. Any mulch disturbed or displaced following application shall be removed and the area remulched as originally specified at no expense to the Contracting Agency. The Contractor shall take precautionary measures to prevent asphalt adhesive materials from marking or defacing structures, pavements, signs, utilities, or plantings.

8-01.3(6)B Soil Binder or Tacking Agent

Soil binders and tacking agents shall be applied in accordance with the manufacturer's recommended requirements.

8-01.3(7) Dates for Application of Seed, Fertilizer, and Mulch

Unless otherwise approved by the Engineer, seeding, fertilizing, and mulching of slopes shall be performed during the following periods:

West of the summit of the Cascade Range — March 1 to May 15 and August 15 to October 1. Where contract timing is appropriate, seeding, fertilizing, and mulching shall be accomplished during the spring period listed above. Written permission to seed after October 1 will only be given when physical completion of the project is imminent and the environmental conditions are conducive to satisfactory growth.

East of the summit of the Cascade Range — August 15 to November 15. Seeding, fertilizing, and mulching shall be accomplished during this fall period only.

All roadway excavation and embankment slopes, including excavation and embankment slopes that are partially completed to grade, must be prepared and seeded during the first available planting period and shall not be allowed to sit idle for long periods of time without receiving the erosion control specified in the Contract.

When environmental conditions are not conducive to satisfactory results from seeding operations, the Engineer may order the work suspended, and it shall be resumed only when the desired results are likely to be obtained.

When environmental conditions are conducive to satisfactory results, the Contractor may elect to perform roadside seeding operations outside of the time periods specified. Inspection of roadside seeding performed at the Contractor's option outside of the time periods specified will be made after one growing season has elapsed. Acceptance will be based on a uniform stand of grass at the time of inspection. The Contractor shall restore eroded areas, clean up eroded materials, and reseed, fertilize, and mulch the areas failing to show a uniform stand of grass. Restoration, reseeding, fertilizing, and mulching shall be performed at no additional cost to the Contracting Agency.

8-01.3(8) Placing Jute Matting, Erosion Control Blanket, or Clear Plastic Covering

Immediately following the establishment of the finished grade, jute matting or erosion control blanket shall be unrolled parallel to the flow of water. Seed and fertilizer shall be placed prior to the placing of erosion control blanket. Where more than one strip of jute matting is required to cover the given area, it shall overlap the adjacent mat a minimum of 100 millimeters. The erosion control blanket shall be placed adjacent to the preceding strip. The ends of both jute matting and erosion control blanket shall overlap at least 150 millimeters with the upgrade section on top. The up-slope end of each jute matting and erosion control blanket shall be staked and buried in a 150-millimeter-deep trench with the soil firmly tamped against the mat. Three stakes per width of matting (one stake at each overlap) shall be driven below the finish ground line prior to backfilling of the trench. The Engineer may require that any other edge exposed to more than normal flow of water or strong prevailing winds be staked and buried in a similar manner.

The edges of jute matting and erosion control blanket shall be buried around the edges of catch basins and other structures. Jute matting and erosion control blanket must be spread evenly and smoothly and in contact with the soil at all points.

Jute matting and erosion control blanket shall be held in place by approved wire staples, pins, spikes, or wooden stakes driven vertically into the soil. The matting and blanket shall be fastened at intervals not more than 1 meter apart in three rows for each strip of the matting and blanket, with one row along each edge and one row alternately spaced in the middle. All ends of the matting and blanket and check slots shall be fastened at 150-millimeter intervals across their width. Length of fastening devices shall be sufficient to securely anchor the matting and blanket against the soil and driven flush with the finished grade.

Clear plastic covering meeting the requirements of Section 9-14.5 shall be installed on erodible embankment slopes as shown in the Plans or as designated by the Engineer.

The clear plastic covering shall be installed immediately after completion of the application of roadside seeding and shall be in place before the fall rainfall begins.

The Contractor shall maintain the cover tightly in place by using sandbags or tires on ropes with a minimum 3-meter grid spacing in all directions. All seams shall be taped or weighted down full length. There shall be at least a 300-millimeter overlap of all seams. The Contractor shall be responsible to immediately repair all damaged areas. Cost for repair and maintenance shall be included in the unit contract price of the jute matting, erosion control blanket, and covering.

8-01.3(9) Protection and Care of Seeded Areas

The Contractor shall be responsible for work described in accordance with Section 1-07.13 and the following requirements:

1. Protect all areas involved against vehicle and pedestrian traffic by use of approved warning signs and barricades.
2. Areas which have been damaged through any cause prior to final inspection, and areas failing to receive a uniform application at the specified rate, shall be reseeded, refertilized, and remulched at the Contractor's expense.
3. Seeded areas within the planting area shall be considered part of the planting area. Weeds within the seeded areas shall be controlled in accordance with Section 8-02.3(3).

8-01.3(10) Inspection

Inspection of any area will be made upon completion of seeding, fertilizing, or mulching. The work in any area will not be measured for payment until a uniform distribution of the materials is accomplished at the specified rate. Areas not receiving a uniform application of seed, fertilizer, or mulch at the specified rate, as determined by the Engineer, shall be reseeded, refertilized, or remulched at the Contractor's expense prior to payment.

8-01.3(11) Mowing

When the proposal contains the bid item "Mowing" or mowing areas are defined, the Contractor shall mow all grass growing areas and slopes 1 to 2.5 or flatter except for naturally wooded and undergrowth areas. Trimming around traffic facilities, structures, planting areas, or other features extending above ground shall be accomplished preceding or simultaneously with each mowing by use of power-driven or hand-operated machinery and tools to achieve a neat and uniform appearance.

Each mowing shall be considered as one coverage of all grass areas to be mowed within a defined area. Prospective bidders shall verify the estimated acreage for mowing as shown in the Plans, the topography, irregularity of the area, slopes involved, and access limitations to determine the appropriate equipment to use. Equipment and tools shall be provided such as, but not limited to, tractor-operated rotary or flail-type grass cutting machines and tools or other approved equipment. Power driven equipment shall not cause ruts or deformation of improved areas. Sickle type grass cutters will be permitted only on slopes of drainage ditches, berms, or other rough areas. The equipment and tools shall be in good repair at all times and maintained so that a clean, sharp cut of the grass will result at all times. The actual number of mowings will be as determined by the Engineer. The height of mowing will be 100 to 150 millimeters or as designated in the Plans or in the Special Provisions.

Mowing equipment shall be operated in such a manner and equipped with suitable guards as to avoid throwing rocks or debris onto the traveled way or off the right of way. Equipment which pulls or rips the grass or damages the turf in any manner will not be permitted. The Engineer will be the sole judge of the adequacy of the equipment, safeguards, and methods of use. The Contractor will not be required to collect or remove clippings from the project except on the traveled way, shoulder, walkway, or other improved areas.

8-01.4 Measurement

Measurement for topsoil, Type A, Type B, and Type C, will be by the cubic meter in the haul conveyance at the point of delivery.

The quantity of excavation taken from roadway excavation, borrow, strippings, or other excavation item to be utilized as topsoil Type B will not be deducted from the pay quantities of the respective items. If haul is to be paid on the excavated item from which topsoil Type B material is taken, no deduction will be made in the mass diagram for the quantity so taken. The topsoil Type B material will be considered as having been hauled into the general distribution of the excavated material.

Seeding, fertilizing, liming, mulching, and soil binder or tacking agent will be measured in hectares by ground slope measurement or through the use of design data.

Asphalt emulsion will be measured by the number of liters used to anchor the mulch and will be determined by the count of the containers in which it is received and the number of liters in each container.

Measurement of jute matting and erosion control blanket and of clear plastic covering will be by the square meter measurement of surface area covered and accepted in accordance with these Specifications and the Plans.

Mowing will be measured by the horizontal measurement of the area mowed for each mowing in hectares.

Water will be measured in accordance with Section 2-07.4.

8-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Topsoil Type ____", per cubic meter.

The unit contract price per cubic meter for "Topsoil Type ____" shall be full pay for providing the source of material for topsoil Type A and C, for excavating, loading, hauling, intermediate windrowing, stockpiling, weed control and removal, placing, spreading, processing, cultivating, and compacting topsoil Type A, Type B, and Type C at the locations shown in the Plans or as directed by the Engineer.

"Seeding", per hectare.

"Seeding and Fertilizing", per hectare.

"Seeding, Fertilizing, and Mulching", per hectare.

"Fertilizing", per hectare.

"Second Application of Fertilizer", per hectare.

"Liming", per hectare.

"Mulching", per hectare.

"Soil Binder or Tacking Agent", per hectare.

"Asphalt Emulsion", per liter.

"Jute Matting", per square meter.

"Erosion Control Blanket", per square meter.

"Clear Plastic Covering", per square meter.

The unit contract price per square meter for "Clear Plastic Covering" shall be full pay to install clear plastic covering, to maintain the covering in place throughout the erosion control period, and to remove the covering when ordered by the Engineer.

"Water", per cubic meter.

No payment will be made for water used to water-in plants or for irrigating plants and lawn located within an area which has a workable sprinkler irrigation system.

"Mowing", per hectare.

8-02 ROADSIDE PLANTING

8-02.1 Description

This work shall consist of planting trees, whips, shrubs, ground covers, cuttings, live stakes, live poles, rhizomes, tubers, and seedlings in accordance with these Specifications and as shown in the Plans or as directed by the Engineer.

Trees, whips, shrubs, ground covers, cuttings, live stakes, live poles, rhizomes, tubers, rootstock, and seedlings will hereinafter be referred to collectively as "plants" or "plant material."

8-02.2 Materials

Materials shall meet the requirements of the following sections:

Soil	9-14.1
Seed	9-14.2
Fertilizer	9-14.3
Mulch and Amendments	9-14.4
Matting	9-14.5
Plant Materials	9-14.6
Stakes, Guys, and Wrapping	9-14.7
Irrigation Water	9-25.2

Botanical identification and nomenclature of plant materials shall be based on descriptions by Bailey in "Hortus Third" or superseding editions and amendments.

8-02.3 Construction Requirements

8-02.3(1) Responsibility During Construction

The Contractor shall ensure adequate and proper care of all plant material and work done on this project until all plant establishment periods required by the contract are complete or until physical completion of the project, whichever is last. Existing vegetation shall not be disturbed unless required by the Contract or approved by the Engineer.

Adequate and proper care shall include, but is not limited to, keeping all plant material in a healthy, growing condition by watering, cultivating, pruning, and spraying. Plant material crowns, runners, and branches shall be kept free of mulch at all times. This work shall include keeping the planted areas free from insect infestation, weeds, litter, and other debris along with retaining the finished grades and mulch in a neat uniform condition.

The Contractor shall have sole responsibility for the maintenance and appearance of the roadside planting.

8-02.3(2) RoadsideWork Plan

Before starting any work as defined in Sections 8-02 and 8-03, the Contractor shall submit a roadside work plan for approval by the Engineer. The roadside work plan shall define the work necessary to provide all contract requirements, including: plant area preparation, planting, plant replacement, irrigation, and weed control in narrative form. The roadside work plan shall include a progress schedule in accordance with Section 1-08.3, a weed control plan, and a plant establishment plan in accordance with Section 8-02.3(12). An emergency contact person for the Contractor shall also be listed. Should any part of the roadside work plan become unworkable at any time, the Contractor shall submit a revised plan.

The weed control plan shall show the scheduling of all weed control measures required under the Contract including, hand weeding, rototilling, applications of herbicides, noxious weed control, and shoulder slope weed control. Target weeds and unwanted vegetation to be removed (no live top growth or roots) shall be identified and listed in the weed control plan.

The plan shall be prepared and signed by a licensed pest control consultant if chemical pesticides are proposed. The plan shall include methods of weed control; dates of weed control operations; and the name, application rate, and Material Safety Data sheets of all proposed herbicides. In addition, the Contractor shall furnish the Engineer with a copy of the current product label for each pesticide and spray adjuvant to be used. These product labels shall be submitted with the weed control plan for approval.

No on-site soil placement, grading, weed control, irrigation, or planting work shall begin until the plan is approved. Upon approval of the weed control plan by the Engineer, the Contractor shall proceed in accordance with the approved plan. Should this plan become unworkable at any time during the life of the contract, the Contractor shall submit and receive approval of a revised plan prior to proceeding with further work.

8-02.3(2)A Chemical Pesticides

Application of chemical pesticides shall be in accordance with the label recommendations, the Department of Ecology, local sensitive area ordinances, and Washington State Department of Agriculture orders. The applicator shall be licensed by the State of Washington for the class of pesticide utilized. The Contractor shall furnish the Engineer evidence that all operators are licensed and that the pesticide used is registered for use by the Washington State Department of Agriculture. The Contractor shall furnish the Engineer a copy of the product label and material safety data sheet for each pesticide to be used. All chemicals shall be delivered to the job site in unopened containers. The licensed applicator shall complete a Commercial Pesticide Application Record (DOT Form 540-509) daily with a copy furnished to the Project Engineer daily.

The Contractor shall use extreme care to ensure confinement of the chemicals within the areas designated. The use of any spray chemical pesticides shall require the use of antidrift and activating agents and a spray pattern indicator.

The Contractor shall assume all responsibility for rendering any area unsatisfactory for planting by reason of chemical application. Damage to adjacent areas either on or off the highway right of way shall be repaired to the satisfaction of the Engineer or the property owner, and the cost of such repair shall be borne by the Contractor.

8-02.3(2)B Noxious Weed Control

Those weeds specified as noxious by the Washington State Department of Agriculture, the local Weed District or the County Noxious Weed Control Board shall be controlled on the project in accordance with the weed control plan or as directed by the Engineer. None of the weeds and unwanted vegetation existing in planting areas will be considered noxious for the purpose of this contract.

8-02.3(2)C Shoulder Slope Weed Control

During the life of the contract, the Contractor shall apply a nonselective residual herbicide to the area between the edge of paved shoulders and a point shown in the Plans or as directed by the Engineer. The Contractor shall make additional applications when ordered by the Engineer. A nonselective herbicide recommended for use adjacent to shrub and grass areas and in ditches shall be used.

8-02.3(3) Planting Area Weed Control

All planting areas shall be prepared so that they are weed and debris free at the time of planting and until completion of the project. The planting areas shall include all planting beds, areas around plants, and those areas shown in the Plans. The planting areas include the entire ground surface, regardless of cover, within all planting zones, types, or areas shown in the Plans.

At no time during the life of the Contract shall the Contractor allow weeds to reach seed stage. The Contractor shall not allow live stolons or roots of unwanted vegetation to remain for more than two weeks after notification that such a condition exists.

All appplications of post-emergent herbicides shall be made while green and growing tissue is present.

Should unwanted vegetation reach the seed stage, in violation of these Specifications, the Contractor shall physically remove and bag the seed heads. All physically removed vegetation and seed heads shall be disposed of off site at no cost to the Contracting Agency.

8-02.3(4) Soil Preparation

The work involved in preparing planting areas shall be conducted so the flow line in drainage channels is maintained. Material displaced by the Contractor's operations which interferes with drainage shall be removed from the channel and disposed of as approved by the Engineer. The planting area shall be weed free with no top growth or live roots before any soil work begins.

Before planting and final grading takes place, the area shall be cultivated when specified in the Plans or the Special Provisions.

Upon completion of cultivation, the areas shall be brought to a uniform grade, 25 millimeters, or the specified depth of mulch, below walks, curbs, junction and valve boxes, and driveways, unless otherwise specified. All excess material and debris, stumps, and rocks larger than 75 millimeters, shall be removed and disposed of off the project site or as approved by the Engineer.

Soil amendments shall be thoroughly mixed with the soil to produce a uniform blend as specified in the Plans or Special Provisions.

8-02.3(5) Soil Amendments

Soil amendments of the type and quantities specified shall be applied where shown in the Plans or Special Provisions.

8-02.3(6) Layout of Planting

In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, seedlings, ground covers, cuttings and live stakes.

All location layout and staking shall be the responsibility of the Contractor, subject to the approval of the Engineer before planting of each item begins.

The Engineer will make only the field measurements necessary to calculate and verify quantities for payment.

All trees to be planted in mowable grass areas shall be located a minimum of 3 meters from the edge of planting beds, other trees, fence lines, and bottom of ditches unless otherwise specified.

Tree locations shown in the Plans shall be considered approximate unless shown with stationing and distance. For locations not shown with stationing and distance, the tree locations shall be located as specified by the Engineer. All trees shall be adjusted in location to clear all overhead lines and structures. All trees shall be set back a minimum of 10 meters

from the edge of the roadway pavement unless otherwise dimensioned in the plans and unless a guardrail, bridge, or a 1 to 2 or steeper backslope intervenes. Then the trees shall be adjusted to a minimum of 6 meters from such structure or 5 meters (slope distance) from the bottom of backslopes.

Tree trunk locations shall be adjusted to a minimum distance of one third the radius of the coverage of sprinkler heads.

Unless otherwise shown, planting beds located adjacent to roadways shall begin at the shoulder subgrade. Where a ditch section exists, no plants shall be placed closer than 1.5 meters from the bottom of the ditch.

8-02.3(7) Planting

No plant material shall be planted until it has been inspected and approved for planting by the Engineer. Rejected material shall be removed from the project site.

Under no circumstances will planting during freezing weather or in frozen ground be permitted. All planting shall be accomplished during the following periods:

1. Nonirrigated Plant Material
   September 15 to March 31.
2. Irrigated Plant Material
   In irrigated areas, no planting shall be done until the irrigation system is operational.

Plants shall not be placed in areas that are below the finished grade.

Planting hole sizes for plant material shall be in accordance with the details shown in the Plans. Any glazed surface of the planting hole shall be removed by hand methods.

Drainage, conforming to the details shown in the Plans, shall be provided for all trees and shrubs.

Plant material supplied in containers shall not be removed from the containers until the time of planting at the planting location. Roots of bare root stock shall not be bunched, curled, twisted, or unreasonably bent when placed in the planting hole. All bare root plant material shall be dormant at the time of planting.

After placing balled and burlapped plants, all inorganic, plastic, or treated burlap and all string or wire lacing shall be completely removed. A burlap-lined wire basket container may be used in lieu of laced burlap. The top 1/2 of the basket shall be removed after the plant is positioned in the planting hole.

The plant material shall be handled in such a manner that the root systems are kept covered and damp at all times. The root systems of all bare root plant material shall be dipped in a slurry of silt and water immediately prior to planting. The root systems of container plant material shall be moist at the time of planting. In their final position, the plants shall have the same relationship to the finished grade as when growing in the nursery or container. After planting, the backfill material and rootball shall be thoroughly watered in within 24 hours.

The Contractor shall provide and apply an anti-desiccant substance to all coniferous plant material and to all deciduous trees (when in leaf) before the plants leave the nursery. The Contractor shall supply a letter of certification that the anti-desiccant has been applied in accordance with the manufacturer's recommendations.

8-02.3(8) Pruning, Staking, Guying, and Wrapping

All plants shall be pruned at the time of planting to remove any minor broken or damaged twigs, branches or roots. Pruning shall be done with a sharp tool and shall be done in such a manner as to retain or to encourage natural growth characteristics of the plants.

When the lowest branch on a 50-millimeter caliper or larger deciduous tree occurs at 1 meter or more from ground level, the trunks shall be wrapped with a tree wrapping material. Tree wrap may be self-adhering or secured using tape. Staples will not be allowed.

Each tree shall be staked or guyed before completion of the backfilling in accordance with the details shown in the Plans.

All staking, guying, and wrapping shall be completely removed at the end of the first year of plant establishment, unless otherwise directed by the Engineer.

8-02.3(9) Fertilizers

Fertilizers shall be applied in the form specified in the Special Provisions. Application procedures shall be in accordance with the manufacturer's recommendations or as specified in the Special Provisions. The Contractor shall submit for approval a guaranteed fertilizer analysis label for the selected product.

8-02.3(10) Bark or Wood Chip Mulch

Bark or wood chip mulch of the type and depth specified shall be applied where shown in the Plans or specified in the Special Provisions. Any contamination of the mulch due to the Contractor's operations shall be corrected to its former condition at the Contractor's expense. Mulch shall be feathered to plant material trunks, stems, canes, or root collars, and 25 millimeters below the top of junction and valve boxes, curbs, and pavement edges. All plant crowns shall be free of mulch. Mulch placed to a thickness greater than specified shall be at no additional cost to the Contracting Agency.

8-02.3(11) Completion of Initial Planting

Upon completion of the initial planting within a designated area, the Engineer will make an inspection of all plant material and notify the Contractor, in writing, of any replacements or corrective action necessary to meet the Contract Provisions. The Contractor shall replace all materials rejected or missing and correct unsatisfactory conditions.

Completion of the initial planting within a designated area includes the following:

1. A minimum of 95 percent of each of the plant material categories (trees, whips, shrubs, groundcovers, and seedlings) shall be installed per the Contract Provisions.
2. Planting Area cleanup.
3. Repairs completed for the entire project, including but not limited to full operation of the irrigation system, complete mulch coverage, and all weeds controlled.
4. Approval of plant establishment plan.

8-02.3(12) Plant Establishment

Plant establishment shall consist of caring for all plants planted on the project and caring for the planted areas within the project limits. The provisions of Section 1-07.13 do not apply to this section.

In accordance with Section 8-02.3(2), the Contractor shall submit a first year plant establishment plan, for approval by the Engineer. The Plan shall show the proposed scheduling of activities, materials, and equipment to be utilized for the first year plant establishment. The Plan shall include the management of the irrigation system. Should the plan become unworkable at any time during the first year plant establishment, the Contractor shall submit a revised plan.

The first year of plant establishment shall begin immediately upon written notification from the Engineer of the acceptance of initial planting for the entire project. The first year plant establishment period shall be a minimum of one calendar year. A second year plant establishment, if included in the Contract, shall begin immediately at the written acceptance of the first year plant establishment period and shall be one full calendar year if there is a third year plant establishment. Without a third year plant establishment, it shall be a minimum of six months or until October 31, whichever is later.

Third year plant establishment, when included in the contract, shall begin immediately at the completion of the second year plant establishment period. If the second year plant establishment period ends on or before May 31, third year plant establishment shall end on October 31 of the same year. If the second year plant establishment period ends after May 31, third year plant establishment shall end on October 31 of the following year.

During the first year plant establishment period, it shall be the Contractor's responsibility to ensure the resumption and continued growth of the transplanted material. This care shall include, but not be limited to, labor and materials necessary for removal of foreign, dead, or rejected plant material, maintaining a weed-free condition, and the replacement of all unsatisfactory plant material planted under this contract. The Contractor shall replace all plants stolen or damaged by the acts of others.

The Contractor shall meet with the Engineer for the purpose of joint inspection of the project on the closest working day to the first day of the month. All conditions unsatisfactory to the Engineer shall be corrected by the Contractor within a 10-day period immediately following the inspection. Corrective work shall include the removal and disposal of all unsatisfactory plant material. Failure to comply with corrective steps as outlined by the Engineer shall constitute justification for the Contracting Agency to take corrective steps and to deduct all costs thereof from any monies due the Contractor. At the end of the plant establishment period, plants which do not show normal growth shall be replaced. Planting dates for replacement plant material will be approved by the Engineer.

All automatic irrigation systems shall be operated fully automatic during the plant establishment period and until final acceptance of the contract.

During the second and third year plant establishment period, the Contractor shall perform work as described above on a force account basis at the direction of the Engineer.

8-02.3(13) Plant Replacement

The Contractor shall be responsible for growing or providing enough plants for replacement of all plant material rejected through first year plant establishment. All rejected plant material shall be replaced at dates approved by the Engineer.

All replacement plants shall be of the same species and quality as the plants they replace. Plants may vary in size reflecting one season of growth should the Contractor elect to hold plant material under nursery conditions for an additional year to serve as replacement plants.

8-02.3(14) Lawn Installation

In irrigated areas, lawn installation shall not begin until the sprinkler system is operational.

Seed mix and rate of application shall be as specified in the Special Provisions.

Unless otherwise approved by the Engineer, seeded lawn installation shall be performed during the following periods of any year at the location shown:

West of the summit of the Cascade Range — March 1 to October 25.

East of the summit of the Cascade Range — April 15 to October 1.

The Contractor shall have the option of sodding in lieu of seeding for lawn installation at no expense to the Contracting Agency. However, seeding in lieu of sodding will not be allowed.

Topsoil for both seeded or sodded lawns shall be placed at the depth and locations shown in the Plans. The topsoil shall be tilled to a depth sufficient to key into the subsoil, raked to a smooth even grade without low areas to trap water and compacted, all as approved by the Engineer.

Sod strips shall be placed within 48 hours of being cut. Placement shall be without voids and have the end joints staggered. The sod shall be rolled with a smooth roller following placement.

Barriers shall be erected, with warning signs where necessary, to preclude pedestrian traffic from access to the newly placed lawn during the establishment period.

8-02.3(15) Lawn Establishment

Lawn establishment shall consist of caring for all new lawn areas within the limits of this project.

The lawn establishment period shall begin immediately after the lawn planting has been accepted by the Engineer and shall extend to the end of four mowings.

During the lawn establishment period, it shall be the Contractor's responsibility to ensure the continuing healthy growth of the turf. This care shall include labor and materials necessary to keep the project in a presentable condition, including but not limited to, removal of litter, mowing, trimming, removal of grass clippings, edging, fertilization, insecticide and fungicide applications, weed control, repairing irrigation system, and repair and reseeding any and all damaged areas.

Mowing shall conform to the requirements of Section 8-02.3(16).

Temporary barriers shall be removed after the grasses have developed into a heavy sod mat and only on written permission from the Engineer.

All work performed under lawn establishment shall comply with established turf management practices.

Acceptance of lawn planting as specified shall be based on a uniform stand of grass and a uniform grade at the time of final inspection. Areas that are bare or have a poor stand of grass, and areas not having a uniform grade through any cause before final inspection, shall be recultivated, regraded, reseeded, or resodded and refertilized as specified at the Contractor's expense.

8-02.3(16) Lawn Mowing

Lawn mowing shall begin immediately after the lawn establishment period has been accepted by the Engineer and shall extend to the end of the contract or the first year plant establishment, whichever is last.

The Contractor shall accomplish the following minimum requirements:

1. Mowing, trimming, and edging shall be done as often as conditions dictate. Maximum height of lawn shall not exceed 75 millimeters. The cutting height shall be 50 millimeters. Cuttings, trimmings, and edgings shall be disposed of off the project site.
2. Water application shall be as often as conditions dictate depending on weather and soil conditions.
3. Provide fertilizer, weed control, and other measures as necessary to maintain a healthy stand of grass.

8-02.4 Measurement

The pay quantities for plant materials will be determined by count of the number of satisfactory plants in each category accepted by the Engineer.

Fertilizer will be measured in kilograms determined by the count of the containers and the mass of fertilizer per container.

Topsoil Type ____, mulch and soil amendments will be measured by the cubic meter in the haul conveyance or container at the point of delivery.

Water will be measured in accordance with Section 2-07.4. Measurement will be made of only that water hauled in tank trucks or similar equipment.

Shoulder slope weed control will be measured along the ground slope and computed in square meters.

Seeded lawn, sod installations, and lawn mowing will be measured along the ground slope and computed in square meters of actual lawn completed, established, and accepted.

8-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following listed bid items that are included in the proposal:

"Plant Selection ____", per each.

"PSIPE ____", per each. (PSIPE is Plant Selection Including Plant Establishment.)

The unit contract price for "Plant Selection ____", per each, and "PSIPE ____", per each, shall be full pay for all materials, labor, tools, equipment, and supplies necessary for weed control within the planting area, planting area preparation, fine grading, planting, cultivating, and cleanup for the particular items called for in the Plans.

As the plants that include plant establishment are obtained, propagated, and grown, partial payments shall be made as follows after inspection by the Engineer:

Payment of 5 percent of the unit contract price, per each, when the plant materials have been contracted, propagated, and are growing under nursery conditions. The Contractor shall provide the Engineer with certification that the plant material has been procured or contracted for delivery to the project for planting within the time limits of the project. The certification shall state the location, quantity, and size of all material.

Payment shall be increased to 15 percent of the unit contract price, per each, upon completion of the initial weed control work.

Payment shall be increased to 60 percent of the unit contract price per each for the contracted plant material in a designated unit area when planted.

Payment shall be increased to 80 percent of the unit contract price per each for contracted plant material at the completion of the initial planting.

Payment shall be increased to the appropriate percentage upon accomplishment of the following phases of plant establishment.

3 months after completion of initial planting	85%
6 months after completion of initial planting	90%
Completion of 1st year plant establishment	100%

As the plants that do not include plant establishment are obtained, propagated, and grown, partial payments shall be made as follows:

Payment of 15 percent of the unit contract price per each when the plant materials have been contracted, propagated, and are growing under nursery conditions. The Contractor shall provide the Engineer with certification that the plant material has

been procured or contracted for delivery to the project for planting within the time limits of the project. The certification shall state the location, quantity, and size of all material.

Payment shall be increased to 90 percent of the unit contract price per each for contracted plant material at the completion of the initial planting.

Payment shall be increased to 100 percent at the physical completion of the contract.

All partial payments shall be limited to the actual number of healthy vigorous plants that meet the stage requirements, limited to plan quantity. Payments at any stage shall not constitute acceptance of plants, nor shall the ownership or title transfer to the Contracting Agency. Materials found not acceptable at any stage shall be rejected and replaced at the Contractor's expense. Previous partial payments made for materials rejected or missing will be deducted from future payments due the Contractor.

"Plant Establishment — Second Year", by force account.

"Plant Establishment — Third Year", by force account.

"Plant Establishment — Second Year" and "Plant Establishment — Third Year" will be paid for in accordance with Section 1-09.6.

"Fertilizer", per kilogram.

"Noxious Weed Control", by force account.

"Noxious Weed Control" will be paid in accordance with Section 1-09.6 for the control of weeds outside the planting and seeding areas. Removal of weeds or unwanted vegetation existing in planting areas will not be paid for under this item.

"Shoulder Slope Weed Control", per square meter.

"Insecticide Application", by force account.

"Fungicide Application", by force account.

"Insecticide Application" and "Fungicide Application" will be paid in accordance with Section 1-09.6 for the work performed.

"Topsoil Type ____", per cubic meter.

"Soil Amendment", per cubic meter.

"Bark or Wood Chip Mulch", per cubic meter.

"Water", per cubic meter.

No payment will be made for water used to water-in plants or for irrigating plants and lawn located within an area which has a workable sprinkler irrigation system.

"Seeded Lawn Installation", per square meter.

"Sod Installation", per square meter.

"Lawn Mowing", per square meter.

The unit contract price per square meter for "Seeded Lawn Installation" or "Sod Installation" shall be full pay for all costs necessary for weed control within the seeding area, to prepare the area, plant or sod the lawn, erect barriers, and establish lawn areas and for furnishing all labor, tools, equipment, and materials necessary to complete the work as specified and shall be paid in the following sequence for healthy, vigorous lawn:

Completion of Lawn Planting	60 percent of individual areas
Mid Lawn Establishment (after 2 mowings)	85 percent of individual areas
Completion of Lawn Establishment (after 4 mowings)	100 percent of individual areas

For the purpose of providing a common proposal for all bidders, the Contracting Agency entered an amount for "Noxious Weed Control", "Insecticide Application", and "Fungicide Application" in the proposal to become a part of the total bid by the Contractor.

8-03 IRRIGATION SYSTEM

8-03.1 Description

This work shall consist of installing an irrigation system in accordance with these Specifications and the details shown in the Plans or as staked.

8-03.2 Materials

Materials shall meet the requirements of Sections 9-15 and 9-29.

8-03.3 Construction Requirements

Location of pipe, tubing, sprinkler heads, emitters, valves, and other equipment shall be as shown in the Plans and shall be of the size and type indicated. No changes shall be made except as approved by the Engineer.

Potable water supplies shall be protected against cross-connections in accordance with applicable Contracting Agency rules and regulations.

Water service connections shall be made by the Contractor as indicated in the Plans and Special Provisions and such installations and equipment shall conform to the requirements set forth by the supplying agency.

Construction of electrical systems shall conform to applicable portions of Sections 8-20 and 9-29.

8-03.3(1) Layout of Irrigation System

The Contractor shall stake the irrigation system following the schematic design shown in the Plans, before the construction begins. Alterations and changes in the layout may be expected in order to conform to ground conditions and to obtain full and adequate coverage of plant material with water; however, no changes in the system as planned shall be made without the prior authorization of the Engineer.

Irrigation Potholing

Existing underground irrigation casing pipe ends shall be located by potholing, as specified by the Engineer.

8-03.3(2) Excavation

Pipe trenches shall be no wider at any point than is necessary to lay the pipe or install equipment. The top 150 millimeters of topsoil, when such exists, shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made. Trench bottoms shall be relatively smooth and of sand or other suitable material free from rocks, stones, or any material which might damage the pipe. Trenches in rock or other material unsuitable for trench bottoms shall be excavated 150 millimeters below the required depth and shall be backfilled to the required depth with sand or other suitable material free from rocks or stones.

Care shall be exercised by the Contractor when excavating trenches near existing trees. Where roots are 50 millimeters and greater in diameter, except in the direct path of the pipe, the pipe trench shall be hand excavated and tunneled. When large roots are exposed, they shall be wrapped with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines adjacent to trees having roots 50 millimeters and less in diameter shall have the sides hand trimmed making a clean cut of the roots. Trenches having exposed tree roots shall be backfilled within 24 hours unless adequately protected by moist burlap or canvas as approved by the Engineer.

Detectable marking tape shall be placed in the trench 150 millimeters directly above, parallel to, and along the entire length of all nonmetallic water pipes and all nonmetallic and aluminum conduits placed under existing or future pavement. The width and burial depth of the tape shall be as recommended by the manufacturer.

8-03.3(3) Piping

All lines shall be a minimum of 500 millimeters below finished grade measured from the bottom of the pipe or as shown in the Plans. All live mains to be constructed under existing pavement shall be placed in irrigation conduits jacked under pavement unless otherwise noted in the plans. All PVC pipe installed under areas to be paved shall be placed in irrigation conduit. Irrigation conduit shall extend a minimum of 300 millimeters beyond the limits of pavement. All jacking operations shall be performed in accordance with an approved jacking plan. Where possible, mains and laterals or section piping shall be placed in the same trench. All lines shall be placed a minimum of 1 meter from the edge of concrete sidewalks, curbs, guardrail, walls, fences, or traffic barriers.

Mainlines and lateral lines shall be defined as follows:

Mainlines: All supply pipe and fittings between the water meter and the irrigation control valves.

Lateral Lines: All supply pipe and fittings between the irrigation control valves and the connections to the irrigation heads. Swing joints, thick walled poly pipe, flexible risers, rigid pipe risers, and associated fittings are not considered part of the lateral line but incidental components of the irrigation heads.

Pipe pulling will not be allowed for installation and placement of irrigation pipe.

8-03.3(4) Jointing

During construction, pipe ends shall be plugged or capped to prevent entry of dirt, rocks, or other debris.

All galvanized steel pipe shall have sound, clean cut, standard pipe threads well fitted. All pipe shall be reamed to the full diameter and burrs removed before assembly. Threaded galvanized steel joints shall be constructed using either a nonhardening, nonseizing multipurpose sealant or teflon tape or paste as recommended by the pipe manufacturer. All threaded joints shall be made tight with wrenches without the use of handle extensions. Joints that leak shall be cleaned and remade with new material. Caulking or thread cement to make joints tight will not be permitted.

PVC pipe, couplings, and fittings shall be handled and installed in accordance with the manufacturer's recommendation. The outside of the PVC pipe shall be chamfered to a minimum of 2 millimeters at approximately 22 degrees. Pipe and fittings shall be joined by solvent welding. Solvents used must penetrate the surface of both pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.

Threaded PVC joints shall be assembled using Teflon tape as recommended by the pipe manufacturer.

On plastic to metal connections, work the metal connection first. Use a nonhardening compound on threaded connections. Connections between metal and plastic are to be threaded utilizing female threaded PCV adapters with threaded schedule 80 PVC nipple only.

Polyethylene pipe and fittings shall be installed in accordance with the manufacturer's recommendations. The ends of the polyethylene pipe shall be cut square and inserted to the full depth of the fitting. Clamps for insert fittings shall be stainless steel.

8-03.3(5) Installation

Galvanized pipe shall be used from the water meter or service connection through the cross-connection control device.

Final position of turf heads shall be between 13 and 25 millimeters above finished grade measured from the top of the sprinkler. All sprinklers adjacent to walks, curbs, and pavement shall be placed as shown in the Plans.

Shrub heads, unless otherwise specified, shall be placed on risers approximately 300 millimeters above finished grade.

Final position of valve boxes, capped sleeves, and quick coupler valves shall be between 13 and 25 millimeters above finished grade or mulch.

Drip irrigation emitters shall be installed in accordance with the manufacturer's recommendations.

8-03.3(6) Electrical Wire Installation

Wiring between the automatic controller and automatic valves shall be direct burial and may share a common neutral. Separate control conductors shall be run from the automatic controller to each valve. When more than one automatic controller is required, a separate common neutral shall be provided for each controller and the automatic valve which it controls. Wire shall be installed adjacent to or beneath the irrigation pipe. Plastic tape or nylon ty-wraps shall be used to bundle wires together at 3-meter intervals, and the wire shall be "snaked" from side to side in the trench. When necessary to run wire separate from the irrigation pipe, the wire shall be bundled and placed under detectable marking tape. When lateral pipe lines have less than 0.5 meter of cover, direct burial wire shall not be adjacent to pipes but shall be placed at a minimum depth of 0.5 meter.

Wiring placed under pavement and walls, or through walls, shall be placed in irrigation casing. Irrigation casing shall not be less than 25 millimeters in diameter, Class 200 PVC.

Splices will be permitted only at junction boxes, valve boxes, pole bases, or at control equipment. A minimum of 0.6 meter of excess conductor shall be left at all splices, terminal and control valves to facilitate inspection and future splicing.

All wiring shall be tested in accordance with Section 8-20.3(11).

8-03.3(7) Flushing and Testing

All gauges used in the testing of water pressures shall be certified correct by an independent testing laboratory immediately prior to use on the project. Gauges shall be retested when ordered by the Engineer.

Automatic controllers shall be tested by actual operation for a period of two weeks under normal operating conditions. Should adjustments be required, the Contractor shall do so according to the manufacturer's direction and test until operation is satisfactory.

Main Line Flushing: All main supply lines shall receive two fully-open flushings, to remove debris that may have entered the line during construction: the first before placement of valves; the second after placement of valves and prior to testing.

Main Line Testing: All main supply lines shall be purged of air and tested with a minimum static water pressure of 1034 kilopascals for 60 minutes without introduction of additional service or pumping pressure. Testing shall be done with one pressure gauge installed on the line, where ordered by the Engineer. An additional pressure gauge shall be installed at the pump when ordered by the Engineer. Lines which show loss of pressure exceeding 34 kilopascals at the ends of specified test periods will be rejected.

The Contractor shall correct rejected installations and retest for leaks as specified herein.

Lateral Line Flushing: All lateral lines shall receive one fully-open flushing prior to placement of sprinkler heads, emitters, and drain valves. The flushing shall be of sufficient duration to remove any dirt or debris that has entered the lateral lines during construction.

Lateral Line Testing: All lateral lines shall be purged of air and tested in place at operating line pressure with a pressure gauge and with all fittings capped or plugged. The operating line pressure shall be maintained for 30 minutes with valves closed and without introduction of additional pressure. Lines which show leaks or loss of pressure exceeding 34 kilopascals at the end of specified test periods will be rejected.

The Contractor shall correct and retest lateral line installations that have been rejected. Throughout the life of the Contract, the Contractor shall repair, flush, and test, all main and lateral lines that have sustained a break or disruption of service. Upon restoration of the water service, the affected lines shall be brought up to operating pressure. The Contractor shall then conduct a thorough inspection of all sprinkler heads, emitters, etc., located downstream of the break, disruption of service, and repair. This inspection is required to ensure that the entire irrigation system is operating properly.

8-03.3(8) Adjusting System

Before final inspection, the Contractor shall adjust and balance all sprinklers to provide adequate and uniform coverage. Spray patterns shall be balanced by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, sprinkler spray patterns will not be permitted on pavement, walks, or structures.

8-03.3(9) Backfill

Backfill shall not be started until all piping has been inspected, tested, and approved by the Engineer, after which backfilling shall be completed as soon as possible. All backfill material placed within 150 millimeters of the pipe shall be free of rocks, roots, or other objectionable material which might cut or otherwise damage the pipe. Backfill from the bottom of the trench to approximately 150 millimeters above the pipe shall be by continuous compacting in a manner that will not damage pipe or wiring and shall proceed evenly on both sides of the pipe. The remainder of the backfill shall be thoroughly compacted, except that heavy equipment shall not be used within 0.5 meter of any pipe. The top 150 millimeters of the backfill shall be of topsoil material or the first 150 millimeters of material removed in the excavation.

8-03.3(10) As Built Plans and System Orientation

Upon physical completion of the work, the Contractor shall submit corrected shop drawings, schematic circuit diagrams, or other drawings necessary for the Engineer to prepare corrected plans to show the work as constructed. These drawings shall be on sheets conforming in size to the provisions of Section 1-05.3.

The Contractor shall conduct a training and orientation session covering the operation, adjustment, and maintenance of the irrigation system. The As Built Plans shall be reviewed and all features explained. At this session, the Contractor shall provide the Engineer with parts lists and service manuals for all equipment. The Contractor shall notify the Engineer in writing two weeks prior to the training and orientation session. The date and time of the session shall be subject to approval of the Engineer.

8-03.3(11) System Operation

The irrigation system shall be completely installed, tested, and automatically operable prior to planting in a unit area except where otherwise specified in the Plans or approved by the Engineer. The Contractor shall be fully responsible for all maintenance, repair, testing, inspecting, and automatic operation of the entire system until all work is considered complete as determined by the final inspection specified in Section 1-05.11.

This responsibility shall include, but not be limited to, draining the system prior to winter and reactivating the system in the spring and at other times as ordered by the Engineer.

For the life of the contract, the Contractor shall be responsible for having annual inspections and tests performed on all cross connection control devices as required and specified by the State Department of Health. Inspections and tests shall be conducted at the time of initial activation and each spring prior to reactivating the irrigation system.

In the spring, when the drip irrigation system is in full operation, the Contractor shall make a full inspection of all emitters. This shall involve visual inspection of each emitter under operating conditions. All adjustments, flushings, or replacements to the system shall be made at this time to ensure the proper operation of all emitters.

8-03.3(12) Cross-connection Control Device Installation

Cross-connection control devices shall be installed, inspected, and tested by the serving utility or designee in accordance with applicable portions of the Washington Administrative Code (WAC 246-290-490) and other applicable regulations as set forth by the Washington State Department of Health and the Washington State Department of Transportation.

During the life of the Contract, these devices shall be inspected and tested annually, or more often if successive inspections indicate repeated failures. Inspections and tests shall be conducted at the time of initial installation, after repairs, and each spring prior to reactivation of the irrigation system. These inspections and tests shall be completed and the results recorded by a licensed Backflow Device Tester (BDT) Operator or by a Contracting Agency Certified Water Works Operator with a CCS-1 or CCS-2 Classification and shall document that the devices are in good operating condition prior to flushing and testing of any downstream water lines. Devices that are defective shall be repaired or replaced.

Inspection and test results shall be recorded on Department of Transportation Form No. DOT 540-020(x) and other forms as may be required by the water purveyor. The completed forms shall be submitted to the appropriate health authority and to the water purveyor when applicable.

8-03.4 Measurement

No unit of measure shall apply to the lump sum price for irrigation system.

8-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when included in the proposal:

"Irrigation System", lump sum.

All costs for furnishing and installing plastic valve boxes where indicated and as detailed in the Plans and all costs of annual inspections and tests performed on cross connection control devices during the life of the contract shall be included in the unit contract price for the complete irrigation system as shown in the Plans or as directed by the Engineer.

The Contracting Agency shall bear all costs for water used for installation and operation of the irrigation system for the life of the contract.

As the irrigation system is installed, the payment schedule will be as follows:

Payment will be made in proportion to the amount of work performed up to 90 percent of the unit contract price for irrigation system when the irrigation system is completed, tested, and inspected.

Payment shall be increased to 95 percent of the unit contract price for irrigation system upon completion of As Built Plans and System Orientation.

Payment shall be increased to 100 percent of the unit contract price for irrigation system upon completion of the first year plant establishment. If there is no first year plant establishment or if the contract is completed, payment will be increased to 100 percent of the unit contract price for irrigation system upon completion of As Built Plans and System Orientation.

8-04 CURBS, GUTTERS, AND SPILLWAYS

8-04.1 Description

This work shall consist of the construction of cement concrete curbs, curbs and gutters, gutters, spillways, asphalt concrete curbs, gutters, spillways, and metal spillways, of the kind and design specified, at the locations shown in the Plans or where designated by the Engineer in accordance with these Specifications and in conformity to the lines and grades as staked.

8-04.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04.1
Drain Pipe	9-05.1
Steel Culvert Pipe and Pipe Arch	9-05.4
Aluminum Culvert Pipe	9-05.5
Structural Steel and Related Materials	9-06
Reinforcing Steel	9-07
Hand Placed Riprap	9-13.2

Asphalt concrete curbs, gutters, and spillways shall be constructed of an asphalt concrete mix that will have a dense, uniform surface and will fully retain its shape, grade, and line after placement. The mix components shall meet applicable requirements for asphalt concrete specified in Section 5-04 and shall be approved by the Engineer.

8-04.3 Construction Requirements

8-04.3(1) Cement Concrete Curbs, Gutters, and Spillways

Cement concrete curb, curb and gutter, gutter, and spillway shall be constructed with air entrained concrete Class 20 conforming to the requirements of Section 6-02.

The foundation for curbs, gutters, and spillways shall be thoroughly compacted and required side forms shall rest throughout their length on firm ground. Side forms for straight sections shall be full depth of the curb. They shall be either metal of suitable gage for the work or surfaced “construction” grade lumber not less than 50 millimeters (commercial) in thickness. Forms used more than one time shall be thoroughly cleaned and any forms which have become worn, splintered, or warped shall not be used again.

The foundation shall be watered thoroughly before the concrete is placed, and the concrete shall be well tamped and spaded or vibrated in the forms. The exposed surfaces shall be finished full width with a trowel and edger. Within 24 hours after the concrete is placed, the forms of the roadway face of curbs shall be removed, and the concrete treated with a float finish. The top and face of the curb shall receive a light brush finish, and the top of the gutter shall receive a broom finish.

Joints in the curb and gutter shall be spaced to match joints in the abutting pavement. If the abutting pavement is not jointed or the curb or gutter is not abutting pavement, joints in the curb and gutter shall be spaced at 4.5-meter intervals. These joints shall be 3 millimeters minimum thickness and constructed to a minimum depth of 25 millimeters by sawing or scoring with a tool which will leave the corners rounded and destroy aggregate interlock to a depth specified for sawing at the joint. Expansion joints filled to full

cross-section with filler 6 millimeters thick shall be placed in the curb and gutter to match joints in the abutting pavement, at bridges, drainage structures, curb returns, and where shown in the Standard Plans.

The concrete shall be cured for 72 hours by one of the methods specified for cement concrete pavement in Section 5-05.

At the option of the Contractor, the curb and gutter may be constructed using approved slip-form equipment. The curb and gutter shall be constructed to the same requirements as the cast-in-place curb and gutter.

A water reducing admixture conforming to the requirements of Section 9-26 may be used provided the finished curb and gutter shall retain its line and shape.

8-04.3(1)A Extruded Cement Concrete Curb

Extruded cement concrete curb shall be placed, shaped, and compacted true to line and grade with an approved extrusion machine. The extrusion machine shall be capable of shaping and thoroughly compacting the concrete to the required cross-section.

The pavement shall be dry and cleaned of loose and deleterious material prior to curb placement. At the Contractor's option concrete curbs shall be anchored to the existing pavement either by placing steel tie bars 300 millimeters on each side of every joint, or by using an adhesive.

Tie bars shall meet the dimensions shown in the Standard Plans. The adhesive shall meet the requirements of Section 9-26 for Type II epoxy resin.

Joints in the curb shall be spaced at 3-meter intervals. Joints shall be cut vertically and to the depth shown in the Standard Plans.

All other requirements for cement curb and cement concrete curb and gutter shall apply to extruded cement concrete curb.

The Contractor may substitute extruded cement concrete curb for extruded asphalt concrete curb upon receiving written permission from the Engineer. There will be no change in unit contract price if this substitution is allowed.

8-04.3(2) Extruded Asphalt Concrete Curbs, and Gutters

Extruded asphalt concrete curb shall be placed, shaped, and compacted true to line and grade with an approved machine capable of shaping and thoroughly compacting the materials to the required cross-section. Immediately prior to placing the curb, a tack coat of asphalt at the rate ordered by the Engineer shall be applied to the surface upon which asphalt concrete curb is to be placed.

Set forms will not be required for forming gutter if slip-form equipment of a type approved by the Engineer is used. Gutter shall be shaped and compacted to the required line, grade, and cross-section. Connections to any type of outlet shall be constructed so as to form a watertight joint.

8-04.3(3) Vacant

8-04.3(4) Metal Spillways

Round metal spillways shall be plain metal drain pipe 200-millimeter diameter and when specified in the contract, the joints shall be sealed with rubber gaskets conforming to the requirements of Section 9-04.4(4). Half round metal spillways shall be half round metal culvert pipe of the size, kind, and thickness shown in the Plans.

In the construction of metal spillways, sufficient bands, elbows, and joints shall be furnished and placed by the Contractor to permit the construction and connection of the spillways as indicated in the Plans so as to carry the drainage from gutters to the inlets and spillways without percolation of the water under and around the structure.

Spillway pipe shall be laid in a trench in the embankment slope and shall not be placed until after the embankment slopes have been completed and dressed to the lines prescribed by the Engineer. The lower end of the pipe spillway shall be adequately protected and supported by hand placed riprap, concrete, or by other means as may be shown in the Plans. After the spillway pipe has been placed and connected, the trench shall be backfilled, thoroughly compacted, and the embankment slopes restored to their original condition.

8-04.3(5) Spillways at Bridge Ends

Where spillways are required to be constructed at bridge ends, they shall be constructed in the embankment slopes as described above and arranged so that they will connect to the bridge drains. The pipe shall be plain metal drain pipe 200-millimeter diameter and the joints shall be sealed with rubber gaskets conforming to the requirements of Section 9-04.4(4).

8-04.4 Measurement

All curbs, gutters, and spillways will be measured by the meter along the line and slope of the completed curbs, gutters, or spillways, including bends. Measurement of cement concrete curb and cement concrete curb and gutter, when constructed across driveways, will include the width of the driveway.

Except for metal spillways, excavation for these structures shall be incidental to the items involved. Structure excavation required for the installation of metal spillways will be measured in accordance with the provisions of Section 2-09.

Hand placed riprap will be measured in accordance with Section 8-15.4.

8-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Cement Conc. Barrier Curb", per meter.
"Cement Conc. Barrier Curb and Gutter", per meter.
"Single Faced Mountable Cement Conc. Curb", per meter.
"Double Faced Mountable Cement Conc. Curb", per meter.
"Mountable Cement Conc. Curb and Gutter", per meter.
"Extruded Curb", per meter.
"Cement Conc. Gutter", per meter.
"Cement Conc. Spillway", per meter.
"Asphalt Conc. Gutter", per meter.
"Asphalt Conc. Spillway", per meter.
"Drain Pipe ____ mm Diam.", per meter.
"Half Round Plain St. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Half Round Tr. 1 St. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Half Round Plain Al. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Half Round Tr. 1 Al. Culv. Pipe ____ mm Th. ____ mm Diam.", per meter.
"Hand Placed Riprap", per cubic meter.

Hand placed riprap will be paid for as provided in Section 8-15.5.

8-05 INTEGRAL CEMENT CONCRETE CURB

8-05.1 Description

This work shall consist of constructing cement concrete curbs integral with the pavement in accordance with these Specifications and in conformity with the dimensions and cross-sections shown in the Plans and to the lines and grades as staked.

8-05.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04.1
Reinforcing Steel	9-07

Commercial concrete meeting the requirements of Section 6-02 may be used if approved by the Engineer.

8-05.3 Construction Requirements

The concrete in the curbs shall be of the same mix and shall conform in all respects to the specifications for the concrete pavement and shall be cured for the same period and in the same manner as the concrete pavement.

The pavement as constructed shall extend to the back of the curb line. The pavement where the curb is to be placed shall be roughened or otherwise treated so that a permanent bond will be secured between the curb and the pavement. The curb forms shall be securely fastened so that the finished curb has a true, uniform alignment. The face of the finished curb shall have a smooth, uniform appearance. The top shall be troweled smooth, and the edge between the face and the top shall be rounded with an edging tool to a radius of one inch, and the top and face of the curb shall receive a light brush finish.

All expansion joints in the pavement shall extend entirely through the curb. Wherever contraction joints occur in the pavement, construction joints conforming to Section 8-04.3(1) shall be constructed in the curb.

8-05.4 Measurement

Measurement of integral cement concrete curb will be by the meter including driveways. The curb shall be only that portion above the pavement; the concrete below the curb shall be included in the measurement in square meters of pavement.

8-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Integral Cement Conc. Barrier Curb", per meter.

"Mountable Integral Cement Conc. Curb", per meter.

8-07 PRECAST TRAFFIC CURB AND BLOCK TRAFFIC CURB

8-07.1 Description

This work shall consist of furnishing and installing precast traffic curb and block traffic curb of the design and type specified in the Plans in accordance with these Specifications and in conformity to the Standard Plans and in the locations indicated in the Plans or as directed by the Engineer.

8-07.2 Materials

Materials shall meet the requirements of the following sections:

Paint Formulas-General	9-08.2
Precast Traffic Curb	9-18.1
Block Traffic Curb	9-18.3
Water Repellent Compound	9-18.4
Sodium Metasilicate	9-18.5

8-07.3 Construction Requirements

8-07.3(1) Installing Curbs

The curb shall be firmly bedded for its entire length and breadth on a mortar bed composed of one part Portland cement and two parts of concrete sand. The anchor grooves in the bottom of the curb shall be entirely filled with the mortar.

Before the cement mortar bed is laid, all dirt shall be cleaned from the pavement surface by washing.

All old pavements and any portion of new pavements constructed under this contract, which are covered with oil or grease within the curb limits, shall be further cleaned as follows:

1. The pavement shall be flushed with water.
2. While the pavement is still wet, sodium metasilicate, complying with the requirements as specified elsewhere herein, shall be evenly distributed over the pavement surface at a rate of 0.5 to 1.0 kilograms per 10 square meters of pavement surface.
3. The sodium metasilicate shall remain on the pavement for at least 15 minutes. Where patches of oil, tar, or grease occur, these areas shall be scrubbed with a brush or broom.
4. The pavement surface shall then be thoroughly rinsed.

All joints between adjacent pieces of curb except joints for expansion and/or drainage as designated by the Engineer shall be filled with mortar composed of one part Portland cement and two parts sand.

The joints between adjacent units of block traffic curb will not require mortaring.

The alignment and the top surface of adjoining sections of curb shall be true and even with a maximum tolerance of 2 millimeters.

For both types of curb, nosing pieces, connecting dividers, and radial sections, as detailed in the Plans, will be required at the ends of the curb lines, at transitions from Type C traffic curb to Type A traffic curb, and at Type A traffic curb installation with radii less than 3 meters.

8-07.3(2) Painting of Curbs

Concrete curbing shall be painted with two full coats of paint formula No. H-2-83 or H-3-83 as shown in the Plans or as designated by the Engineer. The paint can be applied by brush or spray. The second coat shall have glass traffic paint beads sprinkled in the wet paint at the rate of 9 kilograms per 50 meters of curbing. The beads shall conform to the requirements of Section 8-22.2.

8-07.4 Measurement

Type A precast traffic curb and Type A block traffic curb will be measured by the meter along the front face of the curb and return. Type C precast traffic curb and Type C block traffic curb will be measured by the meter along the axis of the curb. Type A nosing pieces and dividers will be measured as Type A curb, and Type C nosing pieces will be measured as Type C curb.

8-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Type A Precast Traffic Curb", per meter.
"Type C Precast Traffic Curb", per meter.
"Type A Block Traffic Curb", per meter.
"Type C Block Traffic Curb", per meter.

8-08 RUMBLE STRIPS

8-08.1 Description

This work shall consist of constructing continuous shoulder rumble strips by grinding asphalt concrete pavement. The work shall include cleanup and disposal of cuttings and other resultant debris.

8-08.2 Vacant

8-08.3 Construction Requirements

The equipment shall have a rotary type cutting head or series of cutting heads capable of grinding one or more recesses in the asphalt concrete as detailed in Standard Plan H-4.

The difference in the surface texture between the high and low surfaces from the grinding shall not exceed 3 millimeters.

Rumble strips shall not be constructed on bridge decks, bridge approach slabs, or cement concrete surfaces. In areas of monuments, drainage structures, induction loop lead-ins, pavement markings or other features which will not allow the rumble strips to be constructed as detailed, the rumble strips shall be eliminated or relocated as approved by the Engineer.

The traveled lanes shall be kept free of cuttings and other construction debris at all times. Immediately upon completion of rumble strip grinding, all cuttings, grinding debris, dust, and other loose materials shall be removed from the rumble strips and shoulder areas. All cuttings and other debris shall be disposed of as designated by the Engineer or shall become the property of the Contractor and be disposed of outside the project limits. Cuttings and other debris shall not be allowed to enter any waterways.

When shown in the Plans, the rumble strips shall be fog sealed in accordance with the requirements of Section 5-04.3(19) following the completion of the continuous shoulder rumble strip. All pavement markings, junction boxes, drainage structures, and similar objects located in the shoulder shall not be fog sealed.

8-08.4 Measurement

Continuous shoulder rumble strips will be measured to the nearest 0.01 kilometer along the mainline roadway for each shoulder. No deductions will be made for required gaps shown on the Standard Plan or for the elimination of rumble strips across bridge decks, bridge approach slabs, cement concrete areas, or other areas approved by the Engineer.

Fog sealing, when shown in the Plans, will be measured as asphalt for tack coat in accordance with Section 5-04.4.

8-08.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when included in the proposal:

"Continuous Shoulder Rumble Strip", per kilometer.

Payment for fog sealing the shoulder, when shown in the Plans, will be paid as asphalt for tack coat in accordance with Section 5-04.5.

8-09 RAISED PAVEMENT MARKERS

8-09.1 Description

This work shall consist of furnishing and installing pavement markers of the type specified in the Plans, in accordance with these Specifications, and at the locations indicated in the Plans or where designated by the Engineer. The color of pavement markers shall conform to the color of the marking for which they supplement, substitute for, or serve as a positioning guide for.

8-09.2 Materials

Raised pavement marker (RPM) shall meet the requirements of the following sections:

RPM Type 1	9-21.1
RPM Type 2	9-21.2
RPM Type 3	9-21.3
Adhesive	9-02.1, 9-26.2

8-09.3 Construction Requirements

8-09.3(1) Surface Preparation

All sand, dirt, and loose extraneous material shall be swept or blown away from the marker location and the cleaned surface prepared by one of the following procedures:

When deemed necessary by the Engineer all surface dirt within areas to receive markers shall be removed. Large areas of tar, grease, or foreign materials may require sandblasting, steam cleaning, or power brooming to accomplish complete removal.

When markers are placed on new cement concrete pavement, any curing compound shall be removed in accordance with the requirements of this section and Section 5-05.3(13)A.

The pavement shall be surface dry, and in cool weather shall be heated by intense radiant heat (not direct flame) for a sufficient length of time to warm the pavement areas of marker application to a minimum of 20°C.

Application of markers shall not proceed until final authorization is received from the Engineer.

8-09.3(2) Marker Preparation

Type 2 markers may be warmed prior to setting by heating to a maximum temperature of 49°C for a maximum of 10 minutes.

8-09.3(3) Adhesive Preparation

The adhesive shall be maintained at a temperature of 15°C to 30°C before use and during application.

Component A shall be added to component B just before use and mixed to a smooth uniform blend. The unused mixed adhesive shall be discarded when polymerization has caused stiffening and reduction of workability.

8-09.3(4) Application Procedure

The marker shall be affixed to the prepared pavement area with sufficient adhesive so as to squeeze out a small bead of adhesive around the entire periphery of the marker. The required amount of adhesive per marker will normally be in the range of 20 to 40 grams.

The sequence of operations shall be as rapid as possible. Adhesive shall be in place and the marker seated in not more than 30 seconds after the removal of the pavement preheat or warm air blast. The marker shall not have cooled more than one minute before seating.

The length of the pavement preheat or warming shall be adjusted so as to ensure bonding of the marker in not more than 15 minutes. Bonding will be considered satisfactory when adhesive develops a minimum bond strength in tension of not less than 12 kilopascals.

Markers shall be spaced and aligned as shown in the Standard Plans and as specified by the Engineer. A displacement of not more than 15 millimeters left or right of the established guide line will be permitted. The Contractor shall remove and replace at no expense to the Contracting Agency all improperly placed markers.

Markers shall not be placed over longitudinal or transverse joints in the pavement surface.

On roadway sections which are not open to public traffic, the preheating of the markers by dry heating before setting will not be required provided the adhesive develops the required bond strength of 12 kilopascals in less than three hours. If the roadway section is carrying public traffic during the installation of the markers, the 15 minute set-to-traffic provision will be enforced, and necessary flagging and traffic control will be required.

Thermoplastic Type 1 markers shall be installed only with a hot melt bitumen adhesive. At the option of the Contractor, a hot melt bitumen adhesive may be used to cement other types of markers to the pavement in lieu of epoxy adhesive. The bitumen adhesive shall conform to the requirements of Section 9-02.1(8).

Markers shall not be placed using bitumen adhesive when the pavement or air temperature is 10°C or less.

Bitumen adhesive shall be indirectly heated in an applicator with continuous agitation. The adhesive shall be applied at a temperature between 200°C and 220°C. Markers shall be placed immediately after application of the adhesive.

8-09.3(5) Recessed Pavement Marker

The Contractor shall grind the pavement marker recess in accordance with the dimensions shown in the Standard Plans. Markers shall be installed in the recess in accordance with the Standard Plans and the Plans.

8-09.4 Measurement

Measurement of markers will be by units of one hundred for each type of marker furnished and set in place.

8-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Raised Pavement Marker Type 1", per hundred.

"Raised Pavement Marker Type 2", per hundred.

"Raised Pavement Marker Type 3-_____ mm", per hundred.

"Recessed Pavement Marker", per hundred.

The unit contract price per hundred for “Raised Pavement Marker Type 1”, “Raised Pavement Marker Type 2”, “Raised Pavement Marker Type 3-_____ mm”, and “Recessed Pavement Marker” shall be full pay for furnishing and installing the markers in accordance with these Specifications including all cost involved with traffic control except for reimbursement for labor for traffic control in accordance with Section 1-10.5.

8-10 GUIDE POSTS

8-10.1 Description

This work shall consist of furnishing and placing flexible guide posts of the type specified in the Plans in accordance with these Specifications and the Standard Plans, at the locations indicated in the Plans or where designated by the Engineer.

8-10.2 Materials

Flexible guide posts and reflective sheeting shall be selected from approved materials listed in the Special Provisions or the Qualified Products List. Flexible guide posts shall be pre-approved in accordance with Section 9-17 prior to use on a project. If a producer lacks access to a regularly conducted Field Operations Support Service Center Materials Laboratory test, the producer may submit for consideration, performance data gained from independent testing attested by a registered Engineer. Acceptance of independent data or repetition of selected or total tests, shall be the prerogative of the Field Operations Support Service Center Materials Laboratory.

Adhesives for surface mounted guide posts shall meet the requirements of Sections 9-02.1(8) and 9-26.2. Other bonding agents may be approved by the Engineer.

8-10.3 Construction Requirements

Flexible guide posts shall be installed as shown in the Standard Plans or as specified by the Engineer. The posts shall be installed plumb, plus or minus $1^1/_2$ degrees.

Guide posts shall be of such length as to provide a height of 1.2 meters, plus or minus 75 mm, above the nearest edge of traveled pavement surface. Surface mounted guide posts shall be bonded to the pavement surface. The final guide post lengths will be determined or verified by the Engineer at the request of the Contractor.

Flexible guide posts shall be installed according to the manufacturer's recommendations. A reasonable time prior to installation, the Contractor shall provide the Engineer with the manufacturer's recommended installation procedures. Only one type of ground mount or guardrail mount flexible guide post shall be used on each project.

If the ground adjacent to the posts is disturbed in any manner, it shall be backfilled to the level of the existing surface and thoroughly compacted. The surface of the ground adjacent to the post shall be replaced with like materials, including bituminous treatment if previously existent.

8-10.4 Measurement

Flexible guide posts will be measured by the unit for each post furnished and installed.

8-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Flexible Guide Post", per each.

8-11 GUARDRAIL

8-11.1 Description

This work shall consist of constructing, modifying, removing, and resetting guardrail and anchors of the kind and type specified in accordance with the Plans, these Specifications, and the Standard Plans in conformity with the lines and grades as staked.

8-11.2 Materials

Materials shall meet the requirements of the following sections:

Beam Guardrail	9-16.3
Rail Element	9-16.3(1)
Posts and Blocks	9-16.3(2)
Galvanizing	9-16.3(3)
Hardware	9-16.3(4)
Anchors	9-16.3(5)
Weathering Steel Beam Guardrail	9-16.8

8-11.3 Construction Requirements

8-11.3(1) Beam Guardrail

8-11.3(1)A Erection of Posts

The posts shall be set to the true line and grade of the highway and spaced as shown in the Plans. When the Plans require that the ends of a section of guardrail be curved outward or downward, the posts shall be set to accommodate the curve. End treatment shall be in accordance with the appropriate Standard Plans or as shown in the Plans.

The length of post installed shall be as shown in the Standard Plans unless long posts are indicated. The length of posts for beam guardrail Type 1 with long posts shall be as specified in the Plans.

Posts may be placed in dug or drilled holes. Ramming or driving will be permitted only if approved by the Engineer and if no damage to the pavement, shoulders, and adjacent slopes results therefrom.

In broken rock embankments, the pre-punching of holes will be permitted only prior to final shoulder or median compaction, surfacing, and paving.

The posts shall be protected from traffic at all times by attaching the rail elements or by a method approved by the Engineer.

8-11.3(1)B Vacant

8-11.3(1)C Erection of Rail

All metal work shall be fabricated in the shop. No punching, cutting, or welding shall be done in the field, except that holes necessary when additional posts are required or for special details in exceptional cases may be drilled in the field when approved by the Engineer. The rail shall be erected so that the bolts at expansion joints will be located at the centers of the slotted holes.

Rail plates shall be assembled with the splice joints lapping in the direction of the traffic.

When nested W-beam or thrie beam is specified, two sections of guardrail, one set inside of the other shall be installed. The inside and outside rail elements shall not be staggered.

Galvanized rail plates shall be fastened to the posts with galvanized bolts, washers, and nuts of the size and kind shown in the Plans. Weathering steel rail plates shall be fastened to the posts with weathering steel bolts, washers, and nuts of the size and kind shown in the Plans and shall not be galvanized.

All bolts, except where otherwise required at expansion joints, shall be drawn tight. Bolts through expansion joints shall be drawn up as tight as possible without being tight enough to prevent the rail elements from sliding past one another longitudinally. Bolts shall be sufficiently long to extend at least 6 millimeters beyond the nuts. Except where required for adjustments, bolts shall not extend more than 13 millimeters beyond the nuts.

After complete installation of weathering steel beam guardrail, the Contractor shall wash the rail with clean water under high pressure. If the rail is contaminated by oil or grease, sandblasting shall be used as necessary to clean the rail.

8-11.3(1)D Terminal and Anchor Installation

All excavation and backfilling required for installation of anchors shall be performed in accordance with Section 2-09, except that the costs thereof shall be incidental to and included in the unit contract price for the type of anchor installed.

Bolts shall be tightened to the tension specified. The anchor cable shall be tightened sufficiently to eliminate all slack. When tightening, the anchor cable shall be restrained to prevent twisting of the cable.

When foundation tubes used with the Wood Breakaway Post are driven, they shall be driven prior to installing the wood post.

Type 2 concrete anchors may either be pre-cast or cast-in-place at the option of the Contractor.

Assembly and installation of guardrail terminals listed in the Qualified Products List shall be supervised at all times by a manufacturer's representative, or an installer that has been trained and certified by the unit's manufacturer. A copy of the installer's certification shall be provided to the Engineer prior to installation. Assembly and installation shall be in accordance with the manufacturer's recommendations.

8-11.3(1)E Plans

The Contractor shall submit for approval of the Engineer such additional detailed plans and shop drawings of rail punchings, fittings, and assemblies as may be required by the Engineer.

8-11.3(2) Guardrail Construction Exposed to Traffic

Any section of beam guardrail that is removed for modification shall be back in place within five calendar days of the date the guardrail is removed.

The Contractor's operations shall be conducted in such a manner that fixed objects and beam guardrail posts shall be protected from traffic at all times by attachment of the rail elements and all associated hardware or by a method approved by the Engineer.

At the end of each day, guardrail sections having an exposed end toward oncoming traffic shall have a Type G terminal end section bolted securely in place.

8-11.3(3) Access Control Gates

Access control gates shall be placed to line and grade as shown in the Plans or as staked. After the posts have been set, the holes shall be backfilled with suitable material and the material thoroughly tamped.

8-11.3(4) Removing Guard Rail

Removal of the various types of guardrail and anchors shall include removal of the rail, cable elements, hardware, posts, concrete bases, and steel tubes. All holes resulting from the removal of the guardrail posts and anchors shall be backfilled with granular material in layers no more than 150 millimeters thick and compacted to the satisfaction of the Engineer. The removed guardrail items shall become the property of the Contractor unless stated otherwise in the Special Provisions.

8-11.3(5) Raising Guardrail

Guardrail shall be raised to the height shown in the Plans, measured from the top of the rail to the finished shoulder surface. The material around each post shall be tamped to prevent settlement of the raised rail.

8-11.4 Measurement

Measurement of beam guardrail and beam guardrail Type 1 long posts will be by the meter measured along the line of the completed guardrail, including expansion sections, and will also include the end section for F connections.

Measurement of beam guardrail transition sections will be per each for the type of transition section installed. End sections, except for F connections, will be considered part of the transition section and will be included in the measurement of the transition section.

Measurement of beam guardrail terminals will be per each for the completed terminal.

Measurement of beam guardrail anchors of the type specified will be per each for the completed anchor, including the attachment of the anchor to the guardrail.

Access control gates will be measured per each.

Measurement of removal of guardrail will be by the meter measured along the line of guardrail removed including transition sections, expansion sections, and terminal sections.

Measurement of removal of guardrail anchors will be per each.

Measurement of raising beam guardrail and removing and resetting beam guardrail will be by the meter measured along the line of guardrail actually raised or removed and reset. This will include transition sections, expansion sections, and terminal sections.

8-11.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Beam Guardrail Type ____", per meter.

"Beam Guardrail Type 1- ____ m Long Post", per meter.

"Weathering St. Beam Guardrail Type ____", per meter.

The unit contract price per meter for "Beam Guardrail Type ____", "Beam Guardrail Type 1- ____ m Long Post", or "Weathering St. Beam Guardrail Type ____" shall include all CRT posts, additional rail elements when nested rail is required, and connection to concrete masonry structures.

"Beam Guardrail Anchor Type ____", per each.

"Beam Guardrail Transition Section Type ____", per each.

The unit contract price per each for "Beam Guardrail Transition Section Type ____" shall include posts, end sections, and connection to masonry structures.

"Beam Guardrail ____ Terminal", per each.

The unit contract price per each for “Beam Guardrail ____ Terminal” shall include the posts, rail, end section, and anchor.

“Access Control Gate”, per each.

“Removing and Resetting Beam Guardrail”, per meter.

“Raising Existing Beam Guardrail”, per meter.

“Removing Guardrail”, per meter.

“Removing Guardrail Anchor”, per each.

8-12 CHAIN LINK FENCE AND WIRE FENCE

8-12.1 Description

This work shall consist of furnishing and constructing chain link fence and wire fence of the types specified in accordance with the Plans, these Specifications, and the Standard Plans at the locations shown in the Plans and in conformity with the lines as staked.

Chain link fence shall be of diamond woven wire mesh mounted on steel posts.

Wire fence shall be of barbed wire or barbed wire combined with wire mesh fastened to posts. Steel posts and steel braces, or wood posts and wood braces may be used, provided only one type shall be selected for use in any contract.

Gates shall consist of a steel frame or frames covered with chain link or wire mesh.

8-12.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Chain Link Fence and Gates	9-16.1
Wire Fence and Gates	9-16.2

8-12.3 Construction Requirements

Clearing of the fence line will be required. Clearing shall consist of the removal and disposal of all trees, brush, logs, upturned stumps, roots of down trees, rubbish, and debris.

For chain link type fences, the clearing width shall be approximately 3 meters. For wire type fences, the clearing width shall be approximately 1 meter. Grubbing will not be required except where short and abrupt changes in the ground contour will necessitate removal of stumps in order to properly grade the fence line. All stumps within the clearing limits shall be removed or close cut.

Grading of the fence line sufficient to prevent short and abrupt breaks in the ground contour that will improve the aesthetic appearance of the top of the fencing when installed shall be required. It is expected that in the performance of this work, machine operations will be required for chain link fencing, and hand work will be required for wire fencing except where sufficient width exists for machine work.

The fence shall be constructed close to and inside the right of way line unless otherwise directed by the Engineer or shown in the Plans. Deviations in alignment to miss obstacles will be permitted only when approved by the Engineer and only when such deviation will not be visible to the traveling public or adjacent property owners.

8-12.3(1) Chain Link Fence and Gates

8-12.3(1)A Posts

Posts shall be placed in a vertical position and, except where otherwise directed by the Engineer, shall be spaced at 3.048-meter centers. Spacing will be measured parallel to the slope of the ground.

All posts, except line posts for Type 3 fence, shall be set in concrete to the dimensions shown in the Plans. All concrete footings shall be crowned so as to shed water. Line posts on Type 3 fence shall be set in undisturbed earth either by driving or drilling, except as specified. Driving shall be accomplished in such a manner as not to damage the post. Voids around the post shall be backfilled with suitable material and thoroughly tamped.

Concrete footings shall be constructed to embed the line posts on Type 3 fence at grade depressions where the tension on the fence will tend to pull the post from the ground.

Where solid rock is encountered without an overburden of soil, line posts shall be set a minimum depth of 350 millimeters, and end, corner, gate, brace, and pull posts a minimum of 500 millimeters into the solid rock. The holes shall have a minimum width 25 millimeters greater than the largest dimension of the post section to be set. The posts shall be cut before installation to lengths which will give the required length of post above ground, or if the Contractor so elects, an even length of post set at a greater depth into the solid rock may be used.

After the post is set and plumbed, the hole shall be filled with grout consisting of one part Portland cement and three parts clean, well graded sand. The grout shall be thoroughly worked into the hole so as to leave no voids. The grout shall be crowned to carry water from the post.

Where solid rock is covered by an overburden of soil or loose rock, the posts shall be set to the full depth shown in the Plans unless penetration into solid rock reaches the minimum depths specified above, in which case the depth of penetration may be terminated. Concrete footings shall be constructed from the solid rock to the top of the ground. Grouting will be required on the portion of the post in solid rock.

Pull posts, as shown in the Standard Plans, shall be braced to adjacent line posts and spaced at 304.8 meters maximum intervals for Type 1, 3, and 6 fence and at 152.4-meter maximum intervals for Type 4 fence.

End, gate, corner, and pull posts shall be braced to the adjacent brace post(s) in the manner shown in the Standard Plans. Changes in line amounting to 0.6-meter tangent offset or more between posts shall be considered as corners for all types of fence.

Steep slopes or abrupt topography may require changes in various elements of the fence. It will be the responsibility of the Contractor to provide all posts of sufficient length to accommodate the chain link fabric and ornamental tops adapted to receive the top rail.

All posts for chain link fence Types 1 and 6 shall be fitted with an approved top designed to fit securely over the post and carry the top rail. All round posts for chain link fence Types 3 and 4 shall have approved tops fastened securely to the posts. The base of the top fitting for round posts shall carry an apron around the outside of the posts.

8-12.3(1)B Top Rail

Top rails shall pass through the ornamental tops of the line posts, forming a continuous brace from end to end of each stretch of fence. Lengths of tubular top rail shall be joined by sleeve couplings. Top rails shall be securely fastened to terminal posts by pressed steel fittings or other appropriate means.

8-12.3(1)C Tension Wire

One continuous length of tension wire shall be used between pull posts. Sufficient tension shall be applied to avoid excess sag between the posts. Tension wires shall be tied or otherwise fastened to end, gate, corner, or pull posts by methods approved by the Engineer.

8-12.3(1)D Chain Link Fabric

Chain link fabric on Type 1, 3, 4, and 6 fence shall be placed on the face of the post away from the highway, except on horizontal curves where it shall be placed on the side designated by the Engineer.

Chain link fabric on Type 1, 3, 4, and 6 fences shall be placed approximately 25 millimeters above the ground and on a straight grade between posts by excavating high points of ground. Filling of depressions will be permitted only upon approval of the Engineer.

The fabric shall be stretched taut and securely fastened to the posts. Fastening to end, gate, corner, and pull posts shall be with stretcher bars and fabric bands spaced at intervals of 380 millimeters or less or by weaving the fabric into the fastening loops of roll-formed posts. Fastening to line posts shall be with tie wire, metal bands, or other approved method attached at 355-millimeter intervals. The top and bottom edge of the fabric shall be fastened with the wires spaced at 610-millimeter intervals to the top rail, or top and bottom tension wires as may be applicable.

Rolls of wire fabric shall be joined by weaving a single strand into the ends of the rolls to form a continuous mesh.

8-12.3(1)E Chain Link Gates

Chain link fabric shall be fastened to the end bars of the gate frame by stretcher bars and fabric bands and to the top and bottom bars of the gate frames by tie wires in the same manner as specified for the chain link fence fabric, or by other standard methods if approved by the Engineer.

Welded connections on gate frames where the spelter coating has been burned shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked spelter removed. The clean areas shall then be painted with two coats of galvanizing repair paint, Formula A-9-73.

The drop bar locking device for the wire gates shall be provided with a 300-millimeter-round by 450-millimeter-deep footing of commercial concrete, crowned at the top and provided with a hole to receive the locking bar. The depth of the penetration of the locking bar into the footing shall be as specified by the manufacturer of the locking device.

8-12.3(2) Wire Fence and Gates

8-12.3(2)A Posts

Line posts shall be spaced at intervals not to exceed 4.3 meters. All intervals shall be measured center to center of posts. In general, in determining the spacing of posts, measurements will be made parallel to the slope of the existing ground, and all posts shall be placed in a vertical position except where otherwise directed by the Engineer.

Line posts may be driven in place provided the method of driving does not damage the post. Steel corner, gate, and pull posts shall be set in commercial concrete footings to the dimensions shown in the Plans and crowned at the top to shed water.

Concrete footings shall be constructed to embed the lower part of steel line posts, and wood anchors shall be placed on wood posts at grade depressions wherever the tension on the line wires will tend to pull the post from the ground. The concrete footings shall be 900 millimeters deep by 300 millimeters in diameter and crowned at the top.

Where solid rock is encountered without an overburden of soil, line posts shall be set a minimum depth of 350 millimeters and end, corner, gate, and pull posts a minimum depth of 500 millimeters into the solid rock. The hole shall have a minimum dimension 25 millimeters greater than the largest dimension of the post section to be set. The posts shall be cut before installation to lengths which will give 1370 millimeters of post above ground, or if the Contractor so elects, 1830-millimeter posts set 450 millimeters into the solid rock may be used.

After the post is set and plumbed, the hole shall be filled with grout consisting of one part Portland cement and three parts clean, well graded sand. The grout shall be thoroughly worked into the hole so as to leave no voids. The grout shall be crowned to carry water away from the post. Where posts are set in the above manner, anchor plates and concrete footings will not be required.

Where solid rock is covered by an overburden of soil or loose rock, the posts shall be set to the full depth of 760 millimeters unless the penetration into solid rock reaches the minimum depths specified above, in which case the depth of penetration may be terminated. When the depth of the overburden is greater than 300 millimeters, anchor plates will be required on the steel line posts, and concrete footings shall be constructed from the solid rock to the top of the ground on steel end, gate, corner, and pull posts. When the depth of overburden is 300 millimeters or less, anchor plates and concrete footings will not be required. Grouting will be required on the portion of the post in solid rock.

Steel braces shall be anchored to soil or loose rock with a commercial concrete footing not less than 450 millimeters on any one side and set in solid rock to a minimum depth of 250 millimeters in the same manner as specified above for posts. The braces shall be set on the diagonal as shown in the Plans and connected to the post with an approved connection.

Wood braces shall be dapped 6 millimeters into the posts and shall be fastened to each post with three 20d galvanized nails.

Wire braces shall consist of a 9 gage wire passed around the wood posts to form a double wire. The wire shall be fastened to each post with two staples and fastened together to form a continuous wire. The wires shall then be twisted together until the wire is in tension.

Where the new fence joins an existing fence, the two shall be attached in a manner satisfactory to the Engineer, end or corner posts being set as necessary.

Pull posts shall be spaced not more than 304.8 meters apart, but spacing shall be such as to use standard rolls of wire mesh with a minimum of cutting and waste.

Changes in alignment of 30 degrees or more shall be considered as corners, and corner posts shall be installed. Where it is deemed by the Engineer that a change in alignment of less than 30 degrees will materially lessen the strength of the fence, the line post at the angle shall be supported by the addition of braces or wires in a manner satisfactory to the Engineer.

8-12.3(2)B Barbed Wire and Wire Mesh

After the pull posts have been placed and securely braced, the barbed wire and mesh shall be pulled taut to the satisfaction of the Engineer, and each longitudinal wire shall be cut and securely fastened to the pull post with devices customarily used for the purpose. Wire or mesh shall not be carried past a pull post, but shall be cut and fastened to the pull post independently for the adjacent spans.

After the tensioning of the wire or mesh between two pull posts, all longitudinal wires shall be properly fastened at proper height to each intervening line post.

Wire mesh and barbed wire shall be placed on the face of the post which is away from the highway, except that on horizontal curves, the mesh and wires shall be fastened to the face on the outside of the curve unless otherwise directed by the Engineer.

Where unusual ground depressions occur between posts, the fence shall be guyed to the ground by means of a 9 gage galvanized wire attached to a deadman of approximately 45 kilograms buried 600 millimeters in the ground. The guy wire shall be securely attached to each strand of barbed wire and to the top and bottom wires of the wire mesh fabric in a

manner to maintain the entire fence in its normal shape. If necessary to guy the fence in solid rock, the guy wire shall be grouted in a hole 50 millimeters in a diameter and 250 millimeters deep. The operation of guying shall leave the fence snug with the ground.

8-12.3(2)C Vertical Cinch Stays

Vertical cinch stays shall be installed midway between posts on both types of fence. The wire shall be twisted in such a manner as to permit weaving into the horizontal fence wires to provide rigid spacing. All barbed wires and the top, middle, and bottom wire of the wire mesh shall be woven into the stay.

8-12.3(2)D Wire Gates

The wire mesh fabric shall be taut and securely tied to the frame and stays in accordance with recognized standard practice for wire gate construction.

Welded connections on gate frames shall be treated as specified for chain link fence gates.

The drop bar locking device for double wire gates shall be provided with a footing of commercial concrete 300 millimeters in diameter and 300 millimeters deep, crowned on top and provided with a hole to receive the locking bar. The diameter and depth of the hole in the footing shall be as specified by the manufacturer of the locking device.

8-12.4 Measurement

Chain link fence and wire fence will be measured by the meter of completed fence, along the ground line, exclusive of openings.

End, corner, and pull posts for chain link fence will be measured per each for the posts furnished and installed complete in place.

Gates will be measured by the unit for each type of gate furnished and installed.

8-12.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Chain Link Fence Type ____", per meter.

Payment for clearing of fence line for "Chain Link Fence Type ____" shall be in accordance with Section 2-01.5.

"End, Corner, and Pull Post for Chain Link Fence", per each.

"Double 4.3 m Chain Link Gate", per each.

"Double 6.1 m Chain Link Gate", per each.

"Single 1.8 m Chain Link Gate", per each.

"Wire Fence Type ____", per meter.

Payment for clearing of fence line for wire fence shall be included in the unit contract price per meter for "Wire Fence Type ____".

"Single Wire Gate 4.3 m Wide", per each.

"Double Wire Gate 6.1 m Wide", per each.

8-13 MONUMENT CASES

8-13.1 Description

This work shall consist of furnishing and placing monument cases and covers, in accordance with the Standard Plans and these Specifications, in conformity with the lines and locations shown in the Plans or as staked.

8-13.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Monument Cases and Covers	9-22.1

8-13.3 Construction Requirements

The concrete base shall be placed on a well compacted foundation. The placing of the monument case and base shall be performed in a manner that will not disturb the monument.

The monument case shall be installed by the Contractor after the final course of surfacing has been placed. After the monument case has been in place for a minimum of three days, the roadway surface shall be patched in a workmanlike manner.

When the monument case and cover are placed in cement concrete pavement, the concrete base will not be required.

The monument will be furnished and set by the Engineer.

8-13.4 Measurement

Measurement of monument case and cover will be by the unit for each monument case and cover furnished and set.

8-13.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Monument Case and Cover", per each.

8-14 CEMENT CONCRETE SIDEWALKS

8-14.1 Description

This work shall consist of constructing cement concrete sidewalks in accordance with details shown in the Standard Plans and these Specifications and in conformity to lines and grades shown in the Plans or as established by the Engineer.

8-14.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04.1
Concrete Curing Materials and Admixtures	9-23

The concrete in the sidewalks shall be air entrained concrete Class 20 in accordance with the requirements of Section 6-02.

8-14.3 Construction Requirements

8-14.3(1) Excavation

Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown in the Plans. All soft and yielding material shall be removed and replaced with acceptable material.

8-14.3(2) Forms

Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. After the forms have been set to line and grade, the foundation shall be brought to the grade required and thoroughly wetted approximately 12 hours before placing the concrete.

8-14.3(3) Placing and Finishing Concrete

The concrete shall be placed in the forms and struck off with a heavy iron-shod straightedge. As soon as the surface can be troweled, it shall be troweled smooth with a steel trowel.

After troweling and before jointing or edging, the surface of the walk shall be lightly brushed in a transverse direction with a soft brush. On grades of over 4 percent, the surface shall be finished with a stipple brush, or as the Engineer may direct.

Expansion joints shall be constructed at the locations and of the sizes as indicated in the Standard Plans.

8-14.3(4) Curing

Concrete sidewalks shall be cured for at least 72 hours. Curing shall be by means of moist burlap or quilted blankets or other approved methods. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may specify.

8-14.4 Measurement

Cement concrete sidewalks will be measured by the square meter of finished surface.

8-14.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Cement Conc. Sidewalk", per square meter.

Payment for excavation of material not related to the construction of the sidewalk but necessary before the sidewalk can be placed, when and if shown in the Plans, will be made in accordance with the provisions of Section 2-03. Otherwise, the Contractor shall make all excavations including haul and disposal, regardless of the depth required for constructing the sidewalk to the lines and grades shown, and shall include all costs thereof in the unit contract price per square meter for "Cement Conc. Sidewalk."

8-15 RIPRAP

8-15.1 Description

This work shall consist of furnishing and placing riprap protection of the type specified at the locations and in conformity with the lines and dimensions shown in the Plans or established by the Engineer.

Riprap will be classified as heavy loose riprap, light loose riprap, hand placed riprap, and sack riprap.

8-15.2 Materials

Materials shall meet the requirements of the following sections:

Filter Blanket ____ (shall meet the gradation requirements for Ballast)	9-03.9(1)
Gravel Backfill for Drains	9-03.12(4)
Heavy Loose Riprap	9-13.1(1)
Light Loose Riprap	9-13.1(2)
Hand Placed Riprap	9-13.2
Sack Riprap	9-13.3
Quarry Spalls	9-13.6

8-15.3 Construction Requirements

8-15.3(1) Excavation for Riprap

The foundation for riprap shall be excavated below probable scour or to the elevation shown in the Plans, and no stone shall be laid or concrete placed until the footing is approved by the Engineer. Excavation below the level of the intersection of the slope to be riprapped and the adjacent original ground or the channel floor or slope shall be classified, measured, and paid for as ditch excavation in accordance with Section 2-10. All excavation or backfill above the level of the above described intersection and all dressing of the slope to be riprapped shall be included in the contract price for the class of riprap to be placed. Before placing riprap, the slopes shall be dressed to the lines and grades as staked.

8-15.3(2) Loose Riprap

Loose riprap shall be placed in such a manner that all relatively large stones shall be essentially in contact with each other, and all voids filled with the finer materials to provide a well graded compact mass. The stone shall be dumped on the slope in a manner that will ensure the riprap attains its specified thickness in one operation. When dumping or placing, care shall be used to avoid disturbing the underlying material. Placing in layers parallel to the slope will not be permitted. A 300-millimeter tolerance for loose riprap will be allowed from slope plane and grade line in the finished surface.

8-15.3(3) Hand Placed Riprap

The stones shall be laid by hand on prepared slopes to such thickness as may be ordered by the Engineer. The riprap shall be started at the toe of the embankment by digging a trench and placing a course of the largest stones therein. Each stone shall be placed so that it shall rest on the slope of the embankment and not wholly on the stone below, and it shall be thoroughly tamped or driven into place. The exposed face of all hand placed riprap shall be made as smooth as the shape and size of the stones will permit and shall not vary more than 75 millimeters from a plane surface on the required slope.

8-15.3(4) Sack Riprap

Sack riprap conforming to the requirements of Section 9-13.3 shall be deposited in the trench and on the slope of the embankment to be protected in accordance with the Plans or as directed by the Engineer.

The concrete shall be placed in the sacks to a uniform volume leaving sufficient room for effectively tying the sacks. The sacks shall then be placed in longitudinal rows in the trench and on the slope to lie parallel with the slope. In placing the sacks on the slope, their outside faces shall be laid against a heavy timber header or screed so that each layer will be true to line and grade. The tied end of the sack shall be turned under and the sack firmly pressed into place against the header or screed. Sacks in the longitudinal rows shall be placed with the bottom of one sack adjacent to the top of the next sack. Joints shall be staggered in succeeding rows. Sack riprap shall not be placed in freezing weather, and work damaged by frost shall be removed and replaced at the Contractor's expense.

8-15.3(5) Vacant

8-15.3(6) Quarry Spalls

Quarry spalls shall be placed in ditches and on slopes to be protected, in accordance with the Plans or as directed by the Engineer. After placement, the quarry spalls shall be compacted by tracked equipment making a minimum of three passes.

8-15.3(7) Filter Blanket

When required, a filter blanket shall be placed on the prepared slope or area to the full thickness specified in the Plans using methods which will not cause segregation of particle sizes within the bedding. The surface of the finished layer shall be even and free from mounds or windrows. Additional layers of filter material, when required, shall be placed using methods which will not cause mixing of the materials in the different layers.

8-15.4 Measurement

Loose riprap will be measured by the tonne or per cubic meter of riprap actually placed.

Hand placed riprap will be measured by the cubic meter of riprap actually placed.

Filter blanket will be measured by the tonne or cubic meter of filter blanket actually placed.

Sack riprap will be measured by the cubic meter. The number of cubic meters of sack riprap placed shall be computed from the number of sacks of cement actually used in the concrete mix and the yield per batch of concrete as determined by the Engineer from actual predetermined measurement.

Quarry spalls will be measured by the tonne or per cubic meter of spalls actually placed.

Ditch excavation will be measured by the cubic meter as specified in Section 2-10.

Excavation for toe walls and trenches will be measured by the cubic meter as ditch excavation in accordance with the provisions of Section 2-10.

8-15.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Heavy Loose Riprap", per tonne or per cubic meter.

"Light Loose Riprap", per tonne or per cubic meter.

"Hand Placed Riprap", per cubic meter.

"Sack Riprap", per cubic meter.

The unit contract price per tonne or per cubic meter for the class or kind of riprap specified above shall be full pay for furnishing all labor, tools, equipment, and materials required to construct the riprap except for excavation. When it is necessary to dump and sort individual loads, payment will be made only for that portion accepted by the Engineer.

"Quarry Spalls", per tonne or per cubic meter.

The unit contract price per tonne or per cubic meter for "Quarry Spalls" shall be full pay for all costs in furnishing, placing, and compacting spalls.

"Ditch Excavation", per cubic meter.

"Filter Blanket", per cubic meter or per tonne.

8-16 CONCRETE SLOPE PROTECTION

8-16.1 Description

This work shall consist of constructing concrete slope protection, in accordance with these Specifications and the details shown in the Plans, at the locations and in conformity with the lines, grades, and dimensions as staked.

Concrete slope protection shall consist of reinforced cement concrete poured or pneumatically placed upon the slope with a rustication joint pattern or semi-open concrete masonry units placed upon the slope closely adjoining each other.

8-16.2 Materials

Materials shall meet the requirements of the following sections:

Concrete Class 20	6-02
Concrete Slope Protection	9-13.5
Semi-Open Concrete Masonry Units Slope Protection	9-13.5(1)
Poured Portland Cement Concrete Slope Protection	9-13.5(2)
Pneumatically Placed Portland Cement Concrete Slope Protection	9-13.5(3)

8-16.3 Construction Requirements

8-16.3(1) Footing and Preparation of Slope

The footing for the slope protection shall be constructed in accordance with Sections 2-09 and 6-02.

The construction of the footing will be incidental to the slope protection, and no separate measurement or payment will be made.

The surface on which application is to be made shall be thoroughly compacted and neatly trimmed to line and grade as necessary to conform to the detail in the Plans.

8-16.3(2) Placing Semi-Open Concrete Masonry Units

The concrete masonry units shall be placed in a uniform plane and in such a manner that they rest firmly and evenly against the slope with no rocking. The concrete masonry units shall be placed in horizontal parallel courses, and successive courses shall break joints with the preceding course to form a running bond.

8-16.3(3) Poured in Place Cement Concrete

The wire mesh shall lap a minimum of one mesh spacing, and laps shall be securely fastened at the ends. During the placement of the concrete, the reinforcement shall be held so as to provide a minimum of 32 millimeters of cover.

Where Class 20 cement concrete is to be placed upon the slope, the method of depositing and compacting shall result in a compact, dense, and impervious concrete which will show a uniform plane surface.

The newly constructed concrete shall be finished by means of a wood float and shall be striated with a rustication joint as shown in the Plans.

Curing shall be performed in accordance with Section 5-05.3(13).

8-16.3(4) Pneumatically Placed Concrete

Workers: Only workers experienced in pneumatically placed concrete shall be employed; and satisfactory evidence of such experience shall be furnished when requested by the Engineer.

Equipment: The Contractor shall furnish the Engineer with two copies of the manufacturer's specifications and operating instructions for the equipment used. Before placement of any portion of the slope protection, the type of equipment and method of operation shall be approved by the Engineer.

Proportions of Materials: The sand/cement ratio shall be $4^1/_2$ parts sand to 1 part cement based on loose dry volume.

Water shall be maintained at a constant pressure which shall be at least 103 kilopascals above atmospheric pressure at the nozzle. For lengths of hose up to 30 meters, pneumatic pressure at the gun shall be 310 kilopascals or greater. Pressure shall be increased 34 kilopascals for each additional 1.5 meters of hose required. A steady pressure shall be maintained.

Method of Application: Portland cement and sand shall be mixed dry, passed through a cement gun and conveyed by air through a flexible tube, hydrated at a nozzle at the end of the flexible tube, and deposited in place by air pressure.

All surfaces are to be wetted, but application shall not be made on any surface on which free water exists.

Reinforcement: The wire mesh shall lap a minimum of one mesh spacing, and laps shall be securely fastened at the ends. During the placement of the concrete, the reinforcement shall be held so as to provide a minimum of 44 millimeters of cover at the recess.

Finishing: The newly constructed concrete shall be finished by means of a wood float and shall be striated with a rustication joint as shown in the Plans.

Curing: Curing shall be in accordance with Section 5-05.3(13).

Protection of Facilities: During the construction, the Contractor shall protect all retaining walls, columns and structures from concrete splash or overspray. Suitable covering shall be provided if such protection is deemed necessary by the Engineer.

Test Cylinders: Two test cylinders shall be made for each full day's operation. The Contractor shall furnish cylinders 150 millimeters in diameter and 300 millimeters high made of 19 millimeters mesh hardware cloth. The test cylinder shall be filled with concrete by utilizing the same pneumatic application described above.

The cylinders shall develop a minimum compressive strength of 20 megapascals at the age of 28 days.

8-16.4 Measurement

Measurement for concrete slope protection will be by the square meter and will include the actual area of the slope covered excluding the footings. The area will be computed on the basis of slope measurements.

8-16.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Conc. Slope Protection", per square meter.

8-17 IMPACT ATTENUATOR SYSTEMS

8-17.1 Description

This work shall consist of furnishing, constructing, repairing, and removing temporary impact attenuator systems and furnishing and constructing permanent impact attenuator systems, including pads, nose covers, and transitions.

8-17.2 Materials

The Contractor shall select impact attenuator systems from the approved list shown in the Plans.

Sand for inertial barrier systems shall be dry and meet the requirements of fine aggregate Class 1 for Portland cement concrete specified in Section 9-03. Urea shall be thoroughly mixed with the sand in an amount equal to 5 percent by mass of the sand to guard against freezing.

8-17.3 Construction Requirements

Assembly and installation shall be supervised at all times by a manufacturer's representative, or an installer that has been trained and certified by the unit's manufacturer. A copy of the installer certification shall be provided to the Engineer prior to installation.

Assembly and installation shall be in accordance with the manufacturer's recommendations. This shall include the connection to concrete barrier or a bridge abutment and the transition section identified in the Plans, construction of steel reinforced concrete pads or anchors, construction of reinforced concrete backup, and attachment to pavement.

The Contractor shall have a complete set of replacement parts on the jobsite for each type of temporary impact attenuator in use on the project and shall repair all damaged impact attenuators immediately. During repair of damaged impact attenuators, the Contractor shall provide necessary traffic control as approved by the Engineer.

Temporary impact attenuators shall not be used for permanent impact attenuators.

As soon as a temporary impact attenuator is no longer needed, as determined by the Engineer, the Contractor shall remove it from the project and it shall remain the property of the Contractor.

8-17.4 Measurement

Temporary and permanent impact attenuators will be measured per each for each installation.

Resetting impact attenuators will be measured per each for each installation that is adjusted or reset to a new location on the project.

8-17.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal.

"Temporary Impact Attenuator", per each.

"Permanent Impact Attenuator", per each.

"Repair Impact Attenuator", by force account as provided in Section 1-09.6.

> To provide a common proposal for all bidders, the Contracting Agency has entered an amount for "Repair Impact Attenuator" in the proposal to become a part of the total bid by the Contractor. No payment will be made for repair of impact attenuators damaged by the Contractor's operations.

"Resetting Impact Attenuator", per each.

The Contracting Agency will not pay for resetting impact attenuators when it is for the benefit of the Contractor's operations.

8-18 MAILBOX SUPPORT

8-18.1 Description

This work shall consist of removing, maintaining in temporary locations during construction, and reinstalling in permanent locations, all mailboxes affected by construction work in accordance with the Plans, these Specifications, and the Standard Plans.

8-18.2 Materials

Materials shall meet the requirements of the following sections:

Tube	9-32.1
Mounting Bracket	9-32.2
Post Mounting Socket and Wedge	9-32.3
Wood Posts	9-32.4
Hardware	9-32.5

Mailboxes will be furnished by others.

8-18.3 Construction Requirements

During construction the mailboxes shall be moved to a temporary location where their usefulness will not be impaired. The boxes shall be reinstalled at the original location or at locations determined by the Engineer in accordance with the Standard Plans.

The existing mailboxes shall be reinstalled on new mailbox supports, in accordance with the Standard Plans, within 24 hours of being removed. The existing mailbox posts shall be removed and disposed of off the project site.

Excavation for new mailbox supports shall be backfilled with adjacent native material and compacted to the satisfaction of the Engineer.

When a newspaper tube is attached to an existing mailbox installation, it shall be removed and attached under the mailbox on the new support, to the satisfaction of the Engineer.

8-18.4 Measurement

Mailbox supports will be measured by the unit for each kind of mailbox support furnished and installed in its permanent location.

8-18.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Mailbox Support, Type ____", per each.

8-19 REDIRECTIONAL LAND FORM

8-19.1 Description

This work shall consist of constructing a redirectional land form in accordance with the Plans, these Specifications, and the Standard Plans at the locations shown in the Plans and in conformity with the lines as staked.

8-19.2 Materials

Unless otherwise shown in the Plans, material to construct the redirectional land form may be any excavation material from the project, subject to the approval of the Engineer.

8-19.3 Construction Requirements

The material to construct the redirectional land form shall be compacted in accordance with Section 2-03.3(14)C, method A.

8-19.4 Measurement

Redirectional land form will be measured by the cubic meter in place.

Topsoil, seeding, fertilizing, mulching, and landscaping, when included in the construction of a redirectional land form, will be measured and paid as shown elsewhere in these Specifications.

8-19.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Redirectional Land Form", per cubic meter.

8-20 ILLUMINATION, TRAFFIC SIGNAL SYSTEMS, AND ELECTRICAL

8-20.1 Description

This work shall consist of furnishing and installing all materials and equipment necessary to complete in place traffic signal, illumination, and other electrical systems, and the modification of such existing systems when so specified, all in accordance with the Plans, the Special Provisions and these Specifications.

Unless otherwise noted, the location of signals, controllers, standards, and appurtenances shown in the Plans are approximate; and the exact location will be established by the Engineer in the field.

8-20.1(1) Regulations and Code

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), FHWA IP-78-16, the Radio Manufacturers Association, the American Society for Testing and Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO), the American National Standards Institute (ANSI), whichever is applicable, and to other codes listed herein. In addition to the requirements of these Specifications, the Plans, and the Special Provisions, all material and work shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code, and any WACs and local ordinances which may apply.

Wherever reference is made in these Specifications or in the Special Provisions to the Code, the rules, or the standards mentioned above, the reference shall be construed to mean the code, rule, or standard that is in effect at the date of advertising of the project.

In accordance with RCW 39.06.010, the Contractor need not be registered or licensed if the Contractor has been prequalified as required by RCW 47.28.070.

Safe wiring labels normally required by the Department of Labor and Industries will not be required on electrical work within the Rights-of-Way of Contracting Agency Highways as allowed in RCW 19.28.360.

Persons performing electrical work shall be certified in accordance with RCW 19.28.510. Proof of certification shall be supplied to the Engineer prior to the performance of the work.

8-20.1(2) Industry Codes and Standards

The following electrical industry codes and standard procedures are listed for reference purposes:

American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street N.W., Suite 225, Washington, D.C. 20001.

American National Standards Institute (ANSI), 70 East 45 Street, New York, New York.

American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania.

American Wood Preservers' Association (AWPA), 836 Seventeenth Street, Washington, D.C.

Edison Electric Institute (EEI), 420 Lexington Avenue, New York, New York.

International Municipal Signal Association (IMSA), P.O. Box 539, 1115 North Main Street, Newark, New York. 14513.

Institute of Transportation Engineers (ITE), 2029 K Street, Washington, D.C.

Insulated Power Cable Engineers' Association (IPCEA), 283 Valley Road, Montclair, New Jersey.

National Electrical Manufacturers' Association (NEMA), 155 East 44th Street, New York, New York.

National Fire Protection Association – National Electrical Code (NEC), 470 Atlantic Avenue, Boston, Massachusetts.

Underwriters' Laboratories (UL), 207 East Ohio Street, Chicago, Illinois.

8-20.2 Materials

Materials shall meet the requirements of Section 9-29.

Unless otherwise indicated in the Plans or specified in the Special Provisions, all materials shall be new.

Where existing systems are to be modified, the existing material shall be incorporated in the revised system, salvaged, or abandoned as specified in the Special Provisions, or as ordered by the Engineer.

8-20.2(1) Equipment List and Drawings

Within twenty days following execution of the Contract, the Contractor shall submit to the Engineer a completed "Request for Approval of Material" that describes the material proposed for use to fulfill the Plans and specifications.

If required to do so, the Contractor shall submit supplemental data, sample articles, or both, of the material proposed for use. Supplemental data (six copies required) would include such items as catalog cuts, product specifications, shop drawings, wiring diagrams, etc. Any material purchased or labor performed prior to such approval shall be at the Contractor's risk. All approvals by the Engineer must be received by the Contractor before materials will be allowed on the job site.

If the luminaires are not listed in the Qualified Products List, the Contractor shall submit six copies of the following information for each different type of luminaire required on the contract:

1. Isocandela diagrams showing vertical light distribution, vertical control limits, and lateral light distribution classification.
2. Details showing the lamp socket positions with respect to lamp and refractor for each light distribution type.

The Contractor shall submit for approval six sets of shop drawings for each of the following types of standards called for on this project:

1. Light standards without pre-approved plans.
2. Signal standards with or without pre-approved plans.

The Contractor will not be required to submit shop drawings for approval for light standards conforming to the pre-approved plans listed in the Special Provisions.

8-20.3 Construction Requirements

8-20.3(1) General

All workmanship shall be complete and in accordance with the latest accepted standards of the industry, as determined by the Engineer.

Existing electrical systems, traffic signal or illumination, or approved temporary replacements, shall be kept in effective operation during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the system. Illumination system shutdowns shall not interfere with the regular lighting schedule unless permitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

Work shall be so scheduled that each electrical system is operational prior to opening the corresponding section of roadway to traffic.

Traffic signals shall not be placed in operation for use by the public without energizing any associated illumination system that is existing or being installed.

All costs incurred by the Contractor for providing effective operation of existing electrical systems shall be included in the associated electrical bid items.

8-20.3(2) Excavating and Backfilling

The excavations required for the installation of conduit, foundations, poles and other appliances shall be performed in a manner to cause the least possible injury to the streets, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed where the least interference to vehicular and pedestrian traffic, and to surface drainage, will occur.

All surplus excavated material shall be removed and disposed of by the Contractor in accordance with Section 2-03, or as directed by the Engineer.

The excavations for foundations shall be backfilled in conformance with applicable requirements of Section 2-09.

Excavations after backfilling shall be kept well filled and maintained in a smooth and well drained condition until permanent repairs are made.

At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time.

8-20.3(3) Removing and Replacing Improvements

Improvements such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material, and any other improvements removed, broken, or damaged by the Contractor, shall be replaced or reconstructed with the same kind of materials as found on the work or with other materials satisfactory to the Engineer.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in Portland cement concrete sidewalks and pavements and asphalt concrete pavements shall be cut to a minimum depth of 75 millimeters with a saw prior to removing the sidewalk and pavement material. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

8-20.3(4) Foundations

Foundation concrete shall conform to the requirements for the specified class, be cast-in-place concrete and be constructed in accordance with Section 6-02.2 and 6-02.3. Concrete for posts, standards, pedestals, and cabinets shall be constructed of concrete Class 20. Steel reinforcing bars for foundations shall conform to Section 9-07.

The bottom of concrete foundations shall rest on firm ground.

Foundations shall be cast in one operation where practicable. The exposed portions shall be formed to present a neat appearance.

The foundations shown in the Plans shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for as extra work as provided in Section 1-04.4.

Forms shall be true to line and grade. Tops of foundations for posts and standards, except special foundations, shall be finished to ground line or sidewalk grade, unless otherwise noted in the Plans or directed by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be plumbed and rigidly placed in proper position and to proper height prior to placing concrete and shall be held in place by means of a template until the forms are removed.

Anchor bolts shall be installed so that two full threads extend above the top of the top heavy-hex nut, except that slip base anchor bolt extensions shall conform to the specified slip base clearance requirements. Anchor bolts shall be installed plumb, plus or minus 1 degree.

Plumbing of standards shall be accomplished by adjusting leveling nuts. Shims or other similar devices for plumbing or raking will not be permitted. After placement of the standard and prior to placing the grout pad, the portion of the anchor bolts above the foundation shall be coated with a heavy body corrosion resistant grease as approved by the Engineer.

The top heavy-hex nuts of light standards and signal standards shall be tightened in accordance with Section 6-03.3(33), and as follows:

1. The top heavy-hex nuts for all clamping bolts of slip base light standards and Type RM and FB signal standards, shall be tightened using a torque wrench to the torque specified in Sections 8-20.3(13)A and 8-20.3(14)E, respectively.
2. The top heavy-hex nuts for all anchor bolts shall be tightened by the Turn-Of-Nut Tightening Method to minimum rotation of 1/4 turn and a maximum rotation of 1/3 turn past snug tight. Permanent marks shall be set on the base plate and nuts to indicate nut rotation past snug tight.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete; however, excess water in the foundation excavation will not be permitted. Forms shall not be removed until the concrete has set at least three days.

Class 2 surface finish shall be applied to exposed surfaces of concrete in accordance with the requirements of Section 6-02.3(14)B.

Where obstructions prevent construction of planned foundations, the Contractor shall construct an effective foundation satisfactory to the Engineer.

The combined height of the light standard concrete foundation plus the anchor bolt stub height shall not exceed 100 millimeters above the ground line.

8-20.3(5) Conduit

Installation of conduit shall conform to appropriate articles of the Code and these Specifications.

The size of conduit used shall be as shown in the Plans. Conduits smaller than 25-millimeter electrical trade size shall not be used unless otherwise specified, except that grounding conductors at service points may be enclosed in 13-millimeter diameter conduit.

It shall be the option of the Contractor, at no expense to the Contracting Agency, to use larger size conduit if desired, and where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. Reducing couplings will not be permitted.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true. Slip joints or running threads will not be permitted for coupling metallic conduit; however, running threads will be permitted in traffic signal head spiders. When a standard coupling cannot be used, an approved threaded union coupling shall be used. The threads on all metallic conduit shall be rust-free, clean and well painted with a good quality colloidal copper suspended in a petroleum vehicle before couplings are made up. All couplings shall be tightened so that a good electrical connection will be made throughout the entire length of the conduit run. If the conduit has been moved after assembly, it shall be given a final tightening from the ends prior to backfilling. Where coating on galvanized conduit has been injured in handling or installing, such injured places shall be thoroughly painted with galvanizing repair paint, Formula A-9-73.

All conduit ends shall be threaded and capped with standard threaded conduit couplings or threaded conduit caps until wiring is started. When couplings or conduit caps are removed, the threaded ends shall be provided with approved conduit bushings. The use of any plugs, even though temporary, in lieu of the conduit couplings and conduit caps is expressly prohibited.

Conduit stubs from bases shall extend at least 150 millimeters from the vertical face of foundations and at least 450 millimeters below grade. All conduit stubs shall be capped.

Conduit stubs, caps, and exposed threads shall be painted with galvanizing repair paint Formula A-9-73.

Metallic conduit bends, except factory bends, shall have a radius consistent with the requirements of Article 346 and other articles of the Code. Where factory bends are not used, conduit shall be bent, using an approved conduit bending tool employing correctly sized dies, without crimping or flattening, using the longest radius practicable.

Nonmetallic conduit bends, where allowed, shall conform to Article 347-13 of the Code.

Conduit shall be laid to a minimum depth of:

1. 0.45 meter below the curb grade in the sidewalk area.
2. 0.60 meter below the roadbed.
3. 1.20 meters below the bottom of ties under railroad tracks.
4. 0.45 meter below the finish grade in all other areas.

Galvanized steel conduit shall be installed at the following locations:

1. All roadbed crossings.
2. All railroad crossings.
3. All runs from the luminaire base to the nearest junction box.
4. All runs installed at traffic signal installations.
5. All pole risers, except as otherwise required by owning utilities.
6. All bends with radius less than 1 meter. Runs embedded within reinforced concrete structures are exempted.
7. All conduit entering junction boxes and service foundations. Where plastic nonmetallic conduit is installed elsewhere in the run, the conduit segment entering the junction box or service foundation shall consist of a 3-meter length of galvanized steel conduit complete with a field bend, approved nonmetallic adapter fitting, equipment grounding conductor, grounding bushing, and bonding jumper connected to equipment grounding. A galvanized steel factory elbow complete with coupling and a 3-meter length of galvanized steel conduit may be installed in lieu of the previously mentioned 3-meter length of galvanized steel conduit with field bend. Runs embedded within reinforced concrete structures are exempted.

8. All other locations noted in the contract.
9. All runs externally attached to structures.

Nonmetallic conduit may be employed as an alternate to metallic conduit at other locations unless specified otherwise in the contract. Nonmetallic conduit installation shall include equipment grounding conductor and shall conform to requirements noted in the Standard Plans. Nonmetallic conduit is not allowed for slipformed barrier.

Aluminum conduit will be an alternate to galvanized steel conduit subject to the following:

1. The use of aluminum conduit shall be restricted to above ground locations; however, all service risers shall be galvanized steel.
2. Aluminum conduit shall not be placed in concrete.

Metallic conduit shall be placed under existing pavement by approved jacking or drilling methods, at locations approved by the Engineer. The pavement shall not be disturbed unless allowed in the Plans, or with the approval of the Engineer in the event obstructions or impenetrable soils are encountered. When approved by the Engineer, small test holes may be cut in the pavement to locate obstructions. When the Contractor encounters obstructions or is unable to install conduit because of soil conditions, as determined by the Engineer, additional work to place the conduit will be paid in accordance with Section 1-04.4.

When open trenching is allowed, trench construction shall conform to the following:

1. The pavement shall be sawcut a minimum of 75 millimeters deep. The cuts shall be parallel to each other and extend 600 millimeters beyond the edge of the trench.
2. Pavement shall be removed in an approved manner.
3. Trench depth shall provide 600 millimeters minimum cover over conduits.
4. Trench width shall be 100 millimeters or the conduit diameter plus 50 millimeters, whichever is larger.
5. Trenches located within paved roadway areas shall be backfilled with 75 millimeters of sand over the conduit, followed by controlled density fill meeting the requirements of Section 2-09.3(1)E. The controlled density fill shall be placed level to, and 75 millimeters below, the surface of the remaining pavement, followed by 75 millimeters of paving material that matches the existing pavement.

Jacking or drilling pits shall be kept 600 millimeters from the edge of any type of pavement wherever possible. Excessive use of water that might undermine the pavement or soften the subgrade will not be permitted.

On new construction, conduit shall be placed prior to placement of base course pavement.

Conduit terminating in foundations other than light standard foundations shall extend a maximum of 50 millimeters above the foundation vertically. At light standard foundations, conduit shall not extend more than 19 millimeters above the foundation.

Conduit entering through the bottom of a junction box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run, terminating 150 to 200 millimeters below the junction box lid and within 75 millimeters of the box wall nearest its entry location.

Suitable marker stakes shall be set at the ends of conduits which are buried so that they can be easily located.

Fittings shall be installed at locations as designated by the Engineer so as to provide a conduit channel that will permit freedom for installing the electrical control wires. When conduit fittings are called for in the Plans, or where their installation is required by the Engineer, the Contractor shall also furnish all necessary covers and gaskets.

All covered underground conduit shall be cleaned with an approved sized mandrel and blown out with compressed air prior to pulling wire.

Conduits installed for future use shall be prepared as follows: After final assembly in place, the conduit shall be blown clean with compressed air. Then, in the presence of the Engineer, a cleaning mandrel correctly sized for each size of conduit shall be pulled through to ensure that the conduit has not been deformed. As soon as the mandrel has been pulled through, both ends of the conduit shall be sealed with conduit caps. No pull wires shall be installed.

Where surface mounting of conduit is required, supports shall consist of "unistrut" type or equal mounting complete with clamps sized for the conduit. Support spacing shall comply with the code or shall be as noted in the contract. Approved expansion fittings shall be installed at all expansion joints. Fasteners shall be as approved by the Engineer.

Existing conduit in place scheduled to receive new conductors shall have any existing conductors removed and a cleaning mandrel sized for the conduit shall be pulled through.

Conduit runs shown in the Plans are for bidding purposes only and may be changed, with approval of the Engineer, to avoid underground obstructions.

8-20.3(6) Junction Boxes

Junction boxes shall be installed at the locations shown in the Plans. The Contractor may install, at no expense to the Contracting Agency, such additional boxes as may be desired to facilitate the work. Junction box installation shall conform to details in the Standard Plans.

Junction boxes shall be adjusted to be flush with the finished grade.

8-20.3(7) Messenger Cable, Fittings

Messenger cable shall be secured to steel strain poles by means of pole bands, and to timber poles by means of single strand guy eye bolts. Pole bands and eye bolts shall be installed as detailed in the Plans.

Messenger cable shall be secured to eye bolts or strain clamps at poles by the use of approved self-locking cable clamp type dead-ending devices. Messenger cable shall be secured to bull rings and anchors by two approved U-bolt connectors and guy thimbles.

Traffic signal control cable shall be secured to the messenger cable by cable ties. The ties shall be black nylon with 530 newtons minimum unlocking strength.

Down guy assemblies shall be installed as detailed in the Standard Plans.

8-20.3(8) Wiring

All underground wiring shall be installed in conduit unless specifically noted otherwise in the contract. All wiring in conduit be installed with an approved lubricant.

With the exception of induction loop circuits, magnetometer circuits and illumination circuits, all wiring shall run continuously, without splices, from a terminal located in a cabinet, compartment, pedestrian push button assembly, or signal head to a similarly located terminal. Terminals located below grade will not be allowed.

All splices in underground illumination circuits, induction loops circuits, and magnetometer circuits shall be installed in junction boxes. The only splice allowed in induction loop circuits and magnetometer circuits shall be the splice connecting the

induction loop lead in conductors or magnetometer lead in conductors to the shielded home run cable. Splices for illumination circuits, including two way, three way and four way splices, shall be epoxy filled clear rigid mold splice kits. Splices for induction loop circuits and magnetometer circuits shall be epoxy filled clear rigid mold splice kits or rigid re-enterable type splice kits. Conductors shall be centered in the splice mold prior to installation of the encapsulation material. All connections shall use copper crimped connectors installed with an approved tool designed for the purpose. All connectors shall be wrapped with two layers electrical tape. All connectors for induction loops and magnetometers shall be soldered. All epoxy splice kits shall be physically separated from other splices and wiring within the junction box to avoid damage from heat during the casting process.

Aerial illumination splices shall employ vice or crimp type pressure connectors. Splice insulation may be epoxy, heat shrink, or tape.

Tape splice insulation shall consist of thermoplastic electrical insulating tape applied to a thickness equal to the original wire insulation. It shall be well lapped over the original insulation, and there shall be a coating of moisture resistant varnish applied and allowed to dry. Two layers of friction tape will then be applied, and the splice shall be finished with a second complete coating of moisture resistant varnish.

Quick disconnect connectors, fused or unfused as required, shall be installed at all poles supporting a luminaire. Installation shall conform to details in the Standard Plans.

Pole and bracket cable shall be installed between the disconnects and the luminaire.

Sufficient slack wire shall be installed at each junction box to allow any conductor, cable, or splice within the junction box to be raised a minimum of 450 millimeters outside of the box.

Insulated grounded conductors of size No. 6 or larger shall be identified either by a continuous white or natural gray finish along its entire length or by an approved white marking for the full length of the visible conductor at all terminations, junction boxes, or accessible locations.

Every conductor at every wire termination, connector, or device shall have a PVC wire marking sleeve bearing as its legend, the circuit number indicated in the contract. All terminal strips shall also bear the circuit number consistent with the contract.

At all illumination circuit splices, each wire entering the splice shall have a PVC wire marking sleeve bearing as its legend the circuit number indicated in the contract.

All wiring, exclusive of the previously mentioned illumination circuits, at junction boxes and at the controller cabinet shall have an approved tag with legends as follows:

1. Individual conductors — the circuit number indicated in the contract.
2. Multiconductor cable — the numbers of the signal heads and/or pedestrian push buttons served.
3. Loop lead-in cable — the numbers of the loops served.
4. Magnetometer cable — the numbers of the magnetometers served.

Drip loops shall be provided on all aerial conductors where they enter poles, signal heads, or weatherheads.

Where direct burial cable or nonmetallic conduit is installed, care shall be used in excavating, installing, and backfilling, so that no rocks, wood, or other foreign material will be left in a position to cause possible injury. Direct burial cable shall be placed a minimum of 600 millimeters below grade and shall be placed loosely in the bottom of a trench. An approved red warning tape shall be installed in the trench, 150 millimeters above the direct buried conductors.

When conductors, either cable or single, are being installed, care shall be exercised to not exceed tension limitations recommended by the manufacturer. Conductors may be pulled directly by hand. However, if conductors are pulled by any mechanical means, a dynamometer with drop-needle hand shall be used on every mechanical pull.

On mechanical pulls, insulation shall be stripped off the individual conductor and the conductor formed into a pulling eye and firmly taped, or a cable grip shall be used. The maximum pulling force applied directly to the conductor; i.e., when pulling eyes are used or when the conductor is formed into a loop, shall be limited to that shown in the following table for copper conductor. When a cable grip is applied over nonmetallic sheathed cables, the maximum pulling force shall be limited to 4.5 kiloNewtons provided this is not in excess of the force as calculated above.

Conductor	Newtons
8	588
6	934
4	1485
3	1873
2	2361
1	2978
1/0	3758
2/0	4736
3/0	5971
4/0	7530

To limit the sidewall pressure at bends in duct and conduit runs, the pulling force in kiloNewtons shall not exceed 1.5 times the radius of the bend in meters. Adequate lubrication of the proper type to reduce friction in conduit and duct pulls shall be utilized as necessary. The grease and oil-type lubricants used on lead sheathed cables shall not be used on nonmetallic sheathed cables.

When wiring is noted for future connection, the ends of each wire or cable shall be sealed with an approved heat shrink end cap.

If loop lead splices are not installed immediately after the installation of the loop leads into the adjacent junction box, the ends of the two conductor “home run” cable shall be sealed with heat shrink end caps to prevent entry of moisture into the two conductor cable. All coaxial cables shall have heat shrink end caps installed prior to aerial or underground installation of the cables to prevent moisture entry into the cable.

Multiconductor cable for signal displays shall be installed entirely through the mounting fitting to a point a minimum of 25 millimeters inside the signal display housing before the outer insulation is stripped back for the connection of individual conductors to the terminal block.

8-20.3(9) Bonding, Grounding

All metallic appurtenances containing electrical conductors (luminaires, light standards, cabinets, metallic conduit, etc.) shall be made mechanically and electrically secure to form a continuous system which shall be effectively grounded. Where metallic conduit systems are employed, the conduit system constitutes the equipment grounding conductor. Where nonmetallic conduit is installed, the installation shall include an equipment grounding conductor as noted in the Standard Plans in addition to conductors called for in the contract. Bonding jumpers and equipment grounding conductors shall be stranded or solid, bare or insulated green copper wire of the same cross-sectional area as No. 8 AWG unless a larger

equipment grounding conductor is required in the Standard Plans. Where parallel circuits are enclosed in a common conduit, the equipment grounding conductor shall be sized by the rating of the largest overcurrent device serving any circuit contained in the conduit.

Identification of the equipment grounding conductor shall conform to all Code requirements.

Grounding of conduit and neutral at the service point shall be accomplished as required under the Code. Grounding of the neutral shall be accomplished only at the service.

Two service grounds shall be installed at each electrical service installation and at each separately derived power source. Each service ground shall conform to the detail in the Standard Plans for "Service Ground." The service ground installations shall be located a minimum of 1.8 meters apart. The first service ground rod shall be connected to a continuous grounding electrode conductor running to the service neutral bus. The second service ground rod shall be connected to the same continuous grounding electrode conductor connected to the first ground rod. Ground electrodes shall be bonded copper, ferrous core materials and shall be solid rods not less than 3 meters in length if they are 13 millimeters in diameter or not less than 2.4 meters in length if they are 16 millimeters or larger in diameter.

The connection of the grounding electrode conductor to the grounding electrode shall be made with two approved ground clamps. All other grounding of the equipment grounding conductors throughout the system shall be by approved grounding bushings and clamps.

Where direct burial cable or aerial illumination wiring is installed, a supplemental ground conforming to details in the Standard Plans shall be installed adjacent to each light standard (timber, steel, or concrete) as detailed in the plans.

Messenger cable shall be bonded to steel strain poles by means of a bond strap connected between an approved U-bolt connector and a bonding lug on the pole.

At points where shields or shielded conductors are grounded, the shields shall be neatly wired and terminated on approved grounding lugs.

8-20.3(10) Service

Power sources shown in the Plans are approximate only; exact location will be determined in the field.

Unless otherwise noted in the Plans or in the Special Provisions, each service shall include a timber pole as specified in Section 9-29.6(3), a meter base installed in accordance with serving utility requirements, a two or three wire service breaker of size noted in the Plans, the necessary conduit risers and ground assembly.

The service breaker shall be a standard thermal circuit breaker encased in a raintight housing that can be padlocked.

Upon request of the Contractor, the Engineer will make the necessary arrangements with the serving utility to complete the service connections. Electrical energy used prior to completion of the contract will be charged to the Contractor, except that the cost of energy used for public benefit, when such operation is ordered by the Engineer, will be borne by the Contracting Agency.

The service cabinet shall be marked with the service agreement letters and numbers. The markings shall be installed on the outside cabinet door near the top of the cabinet. The markings shall be series C using stencils and black enamel alkyd gloss paint conforming to Federal Specification TT-E-489.

8-20.3(11) Field Test

The Contractor shall conduct the following tests on all electrical circuits with nominal operating voltage between 115 volts and 600 volts, other than direct burial installations, in the presence of the Engineer:

1. Test the continuity of each circuit.
2. Test for grounds in each circuit, which shall consist of the physical examination of the installation to ensure that all required ground jumpers, devices, and appurtenances do exist and are mechanically firm.
3. A 500 volt megohm meter test on each circuit between the conductor and ground with all switch boards, panel boards, fuse holders, switches, receptacles, and overcurrent devices in place. All readings shall be recorded. The Contractor shall furnish the Engineer with three copies of the test results identifying observed readings with their respective circuits.

The insulation resistance shall not be less than 6 megohms between the conductor and ground on circuits with a total single conductor length of 760 meters and over, nor less that 8 megohms on circuits with single conductor length of less than 760 meters.

Any change in the above stated minimum readings must be approved in writing by the Engineer. Only those factors based on dialectric properties of conductor insulations, splicing insulations, terminal strip castings, etc., will be cause for consideration of a variance.

4. A functional test in which it is demonstrated that each and every part of the system functions as specified.

For those circuits below 115 volts nominal, except induction loop circuits and direct burial circuits, the circuits shall be tested for continuity, ground, and a test to demonstrate the circuit functions as specified. The megger test shall show an insulation resistance of not less than 2 megohms to ground.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears.

When the project includes a traffic signal system, the Contractor shall conduct tests noted in Section 8-20.3(14)D. The Contractor shall provide the Engineer a minimum of five days advance written notice of the proposed traffic signal turn-on date and time. The traffic signal turn-on procedure shall not begin until all required channelization, pavement markings, and signs are installed. The Contractor shall provide traffic control to stop all traffic from entering the intersection and shall then turn the traffic signal system to its flash mode to verify proper flash indications. The Contractor shall then conduct functional tests to demonstrate that each part of the traffic signal system, illumination system, or other electrical system functions as specified. This demonstration shall be conducted in the presence of a Contracting Agency electronic technician, the Contracting Agency electrical inspector, and Regional Traffic Engineer. The Contractor shall then turn the traffic signal to stop and go operation for no less than one full cycle. Based on the results of the turn-on, the Engineer will direct the Contractor to either turn the traffic signal on to normal stop and go operation, to turn the signal to flash mode for a period not to exceed five calendar days, or to turn the signal off and cover all signal displays.

If the Contractor is directed to turn off the traffic signal, the Contractor shall schedule a new turn-on date with the Engineer in accordance with the previously mentioned procedures.

A qualified representative of the controller supplier shall be present for the turn on to stop and go operation if the controller is being supplied on the contract.

No change to stop and go operation will be allowed after 2 p.m. on any day nor will the change be allowed on Friday, weekends, holidays, or the day preceding a holiday.

8-20.3(12) Painting

All painting required shall be done in conformance with applicable portions of Section 6-07.

Prior to painting, all galvanized surfaces shall be treated as specified in Section 6-07.3(4).

Galvanized steel, aluminum or concrete light standards and luminaires shall not be painted.

8-20.3(13) Illumination Systems

8-20.3(13)A Light Standards

Light standards shall be handled when loading, unloading, and erecting in such a manner that they will not be damaged. Any parts that are damaged due to the Contractor's operations shall be repaired or replaced at the Contractor's expense, to the satisfaction of the Engineer.

Light standards shall not be erected on concrete foundations until foundations have set for 72 hours or attained a compressive strength of 16,500 kPa, and shall be raked sufficiently to be plumb after all load has been placed, or as otherwise directed by the Engineer.

Slip base installation shall conform to the following:

1. The slip plane shall be free of obstructions such as protruding conduit or anchor bolts. The conduit, anchor bolts, and other obstructions shall terminate at a height at or below the elevation of the top of the bottom slip plate.
2. Washers in the slip plane shall be placed between the bottom slip plate and the keeper plate.
3. Anchor bolts shall extend through the top heavy-hex nut two full threads to the extent possible while conforming to the specified slip base clearance requirements. Anchor bolts shall be tightened by the Turn-Of-Nut Tightening Method in accordance with Sections 6-03.3(33) and 8-20.3(4).
4. Clamping bolts shall be tightened in accordance with Sections 6-03.3(33) and 8-20.3(4). The clamping bolts shall be tightened to the specified torque, plus or minus 2 percent, in two stages using an accurately calibrated torque wrench before erecting the light standard. Except as otherwise specified, the Contractor shall install M24 clamping bolts in all slip bases to a torque of 129 newton-meters. The Contractor shall tighten the M27 clamping bolts of slip bases for 15.2 meter light standards with double 3.1 meter mast arms or greater to a torque to 141 newton-meters.
5. The galvanized surfaces of the two slip plates and the keeper plate shall be smooth, without irregularities, to reduce friction and to prevent slackening of bolt tension due to flattening of the irregularities.
6. Anchor bolts damaged after the foundation concrete is placed shall not be repaired by bending or welding. The Contractor's repair procedure is to be submitted to the Engineer for approval prior to making any repairs. The procedure is to include removing the damaged portion of the anchor bolt, cutting threads on the undamaged portion to remain, the installation of an approved threaded sleeve nut and stud, and repairing the foundation with epoxy concrete repair.

7. The grout pad shall not extend above the elevation of the bottom of the slip base.
8. Wiring for slip base installation shall conform to details in the Standard Plans.

Breakaway coupling installation shall conform to the following:

1. At existing foundations, the anchor nuts, pole, grout pad, and leveling nuts shall be removed. Conduits shall be cut to a maximum height of 50 millimeters above the foundation. Anchor bolts that are damaged shall be repaired with approved sleeve nuts as noted under slip base installation procedures.
2. Anchor bolts shall be cut off 64 to 75 millimeters above the foundation. At new foundations, the anchor bolts shall be installed with top of bolt 64 to 75 millimeters above the foundation.
3. Couplings shall be installed to within 3 to 10 millimeters of the foundation. Couplings shall then be leveled.
4. The pole shall be set and plumbed; and washers, nuts, and skirt installed per manufacturer's recommendations.

Slip base insert installations shall conform to details in the Standard Plans, and shall conform to items 1 through 8 above for slip base installation, except that the specified torque for the M22 clamping bolts shall be 68 newton-meters.

All new light standards shall have an approved metal tag riveted to the pole above the handhole. The following information shall be stamped on the tag:

1. Luminaire number.
2. Luminaire wattage.
3. Luminaire voltage.

All new light standards shall be numbered for identification in accordance with the Plans using painted 75-millimeter series C numbers installed 1 meter above the base facing the traveled way. Paint shall be black enamel alkyd gloss conforming to Federal Specification TT-E-489.

In setting timber poles, the Contractor shall provide a minimum burial of 10 percent of the total pole length plus 0.6 meter and shall plumb or rake the poles as directed by the Engineer.

8-20.3(13)B Luminaires

The Contractor shall mark the installation date on the inside of the luminaire ballast housing using a permanent marking pen.

8-20.3(14) Signal Systems

8-20.3(14)A Signal Controllers

All control cabinets and control equipment shall be factory wired ready for operation. Field work will be limited to placing cabinets and equipment and the connecting field wiring to field terminal strips. All controller cabinets shall be installed on a silicone seal pad.

Controllers for portable traffic signal systems shall either conform to the requirements of Section 9-29.13(7) or they shall have been approved as being an operational equivalent.

8-20.3(14)B Signal Heads

Unless ordered otherwise by the Engineer, signal heads shall not be installed at any intersection until all other signal equipment is installed and the controller is in place, inspected, and ready for operation at that intersection, except that the signal heads may be mounted if the faces are covered with a black opaque material.

The signal head covering material shall be of sufficient size to entirely cover the display. The covering shall extend over all edges of the signal housing and shall be securely fastened on the back.

8-20.3(14)C Induction Loop Vehicle Detectors

Induction loops shall be constructed as detailed in the Contract and the following:

1. Loop wire shall conform to Section 9-29.3.
2. Lead-in cable shall conform to Section 9-29.3.
3. All loops shall be installed after grinding or prior to paving the final lift of asphalt designated in the Contract.
4. Each loop shall be the size and number of turns indicated in the Plans.
5. No loop installation will be done in rainy weather or when the pavement is wet.
6. All sawcuts shall be cleaned with a high pressure washer and dried with 700 kilopascals minimum air pressure, to the satisfaction of the Engineer. If traffic is allowed over the sawcut prior to wire installation, the sawcuts shall be cleaned again.
7. Wiring shall be installed with a blunt-nosed wooden wedge.
8. All slack shall be removed from the wiring prior to installation of rope. Kinks in wiring or folding back of excess wiring will not be allowed.
9. Sawcut sealant shall conform to ASTM D 312 Type 4. Other sealants may be used if approved by the Engineer.
10. Sealant shall be applied such that air bubbles or foam will not be trapped in the sawcut.

8-20.3(14)D Test for Induction Loops and Lead-in Cable

All tests shall be performed by the Contractor in the presence of the Engineer for each loop. The tests shall be performed at the amplifier location after complete installation of the loop. All costs associated with testing shall be included in the unit contract prices of the respective bid items.

Test A — The DC resistance between the two lead-in cable wires will be measured by a volt ohm meter. The resistance shall not exceed 5 ohms.

Test B — A megohm meter test at 500 volts DC shall be made between the lead-in cable shield and grounding, prior to connection to grounding. The resistance shall equal or exceed 50 megohms.

Test C — A megger test shall be made between the loop circuit and grounding. The resistance shall equal or exceed 50 megohms.

Test D — This is an inductance test to determine the inductance level of each inductance loop. The Contractor shall record the inductance level of each inductance loop installed on the project and shall furnish the findings to the Engineer. An inductance level below 150 microhenries is considered a failure for a Type 1 loop, and an inductance level below 75 microhenries is considered a failure for a Type 2 loop.

If any of the installations fails to pass all tests, the loop installation or lead-in cable shall be repaired and replaced and then retested.

8-20.3(14)E Signal Standards

Traffic signal standards shall be furnished and installed in accordance with the methods and materials noted in the contract and the following:

1. All dimensions and orientations will be field verified by the Engineer prior to fabrication.

2. The signal standard component identification shall conform to details in the Plans.
3. Disconnect connectors complete with pole and bracket cable shall be installed in any signal standard supporting a luminaire. Illumination wiring installation shall conform to details in the Plans for slip base wiring.
4. No field drilling will be allowed on signal mast arms except for the installation of any required pre-empt indicators or detectors.
5. All pole entrances required for pole-mounted signal heads, cabinets, signs, pedestrian push button assemblies, etc., shall be field drilled.
6. Damage to the galvanized pole surface resulting from field drilling shall be repaired with approved zinc rich paint.
7. Field welding will not be allowed, except as shown in the Plans or as otherwise approved by the Engineer.
8. All tenons shall be factory installed.
9. All welding shall be completed prior to galvanizing.
10. Foundations shall be constructed to provide the pole orientation noted in the Plans. Anchor bolts shall be tightened in accordance with Sections 6-03.3(33) and 8-20.3(4).
11. Slip base installation for Type RM and FB signal standards shall conform to the slip base installation requirements specified in Section 8-20.3(13)A, except that the specified torque for the M20 clamping bolts shall be 68 newton-meters.
12. The pole shall be plumbed after signal heads are installed.
13. The space between the bottom base plate and the top of foundation shall be filled with grout, with a 10-millimeter plastic drain tube.

Signal standards shall not be erected on concrete foundations until foundations have attained a compressive strength of 16,500 kPa.

Signal supports used with portable traffic signal systems shall provide a minimum of two signal displays, spaced a minimum of 2.5 meters apart. When portable traffic signals are used to provide alternating one way control, a minimum of one of the signal displays shall be suspended over the traveled way. The minimum vertical clearance to the traveled way for this signal display is 5.03 meters.

8-20.3(15) Grout

Grout shall conform to the requirements of Section 6-02.3(20).

8-20.3(16) Reinstalling Salvaged Material

When salvaged electrical equipment is to be reinstalled, the Contractor shall furnish and install all necessary materials and equipment, including anchor bolts, nuts, washers, concrete, etc., required to complement the salvaged equipment in the new installation.

Metal poles relocated to new permanent locations shall be inspected for structural integrity prior to reinstalling.

8-20.3(17) "As Built" Plans

Upon physical completion of the work, the Contractor shall submit corrected shop drawings, schematic circuit diagrams, or other drawings necessary for the Engineer to prepare corrected plans to show the work as constructed.

These drawings shall be on sheets conforming in size to the provisions of Section 1-05.3.

8-20.4 Measurement

When shown as lump sum in the Plans or in the proposal as illumination system ____, traffic signal display and detection system ____, or traffic signal control system ____, no specific unit of measurement will apply, but measurement will be for the sum total of all items for a complete system to be furnished and installed.

Conduit of the kind and diameter specified will be measured by the meter for the actual neat line length in place, unless the conduit is included in an illumination system, signal system, or other type of electrical system lump sum bid item.

8-20.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Illumination System ____", lump sum.

"Traffic Signal Display and Detection System ____", lump sum.

"Traffic Signal Control System ____", lump sum.

The lump sum contract price for "Illumination System ____", "Traffic Signal Display and Detection System ____", and "Traffic Signal Control System ____", shall be full pay for the construction of the complete electrical system, modifying existing systems, or both, as shown in the Plans and herein specified including excavation, backfilling, concrete foundations, conduit, wiring, restoring facilities destroyed or damaged during construction, salvaging existing materials, and for making all required tests. All additional materials and labor, not shown in the plans or called for herein and which are required to complete the electrical system, shall be included in the lump sum contract price.

"Conduit Pipe ____ mm Diam.", per meter.

The unit contract price per meter for "Conduit ____ mm Diam." shall be full pay for furnishing all pipe, pipe connections, elbows, bends, caps, reducers, conduits, and unions; for placing the pipe in accordance with the above provisions, including all excavation or jacking required, backfilling of the trenches, chipping of pavement, and bedding of the pipe; and all other work necessary for the construction of the conduit, except that when conduit is included on any project as an integral part of an illumination or traffic signal system and the conduit is not shown as a pay item, it shall be included in the lump sum price for the system shown.

All costs for installing conduit containing both signal and illumination wiring shall be included in the contract prices for the signal system.

All costs for installing junction boxes containing both illumination and signal wiring shall be included in the contract prices for the signal system.

8-21 PERMANENT SIGNING

8-21.1 Description

This work shall consist of furnishing and installing permanent signing, sign lighting, sign removal, sign relocation, and refacing existing signs in accordance with the Plans, these Specifications, and the Standard Plans at the locations shown in the Plans or where designated by the Engineer.

8-21.2 Materials

Signing materials and fabrication of signs shall meet the requirements of Section 9-28. Materials for sign bridges, cantilever sign structures, roadside sign structures, and sign mounting shall meet the requirements of Section 9-06.

8-21.3 Construction Requirements

8-21.3(1) Location of signs

Signs are located in the Plans by station numbers. These are tentative locations subject to change by the Engineer. The post lengths specified in the Plans are estimated for bid purposes only. Final lengths of timber posts will be determined or verified by the Engineer at the request of the Contractor prior to fabrication. Final lengths of steel posts will be determined by the Engineer prior to fabrication.

8-21.3(2) Placement of Signs

All reflectorized signs located less than 9 meters from the edge of the lane should be turned out approximately 3 degrees from the pavement edge of oncoming traffic lanes, and those located 9 meters or more from the edge of the lane should be turned in approximately 3 degrees from the pavement edge of oncoming traffic lanes. All sign posts shall be plumb and signs level. The signs shall be inspected at night by the Engineer and, if specular glare occurs from failure to install at 3 degrees as stipulated, the Contractor shall reinstall the signs at no expense to the Contracting Agency. The post holes shall be of sufficient dimensions to allow placement and thorough compaction of selected backfill material completely around the post. Selected backfill material shall consist of earth or fine sandy gravel free from organic matter with no individual particles exceeding 38 millimeters in diameter.

8-21.3(3) Sign Covering

When notified by the Engineer, the Contractor shall cover or uncover certain signs to facilitate and control the operation of the project. The covering shall consist of 100 micrometers minimum thickness black polyethylene sheeting of sufficient size to entirely cover the sign unless otherwise approved by the Engineer and shall extend over the edges of the sign and fastened on the back. The Contractor shall not use any type of adhesive tape on the face of the signs. Other methods of covering may be considered if approved by the Engineer.

8-21.3(4) Sign Removal

Where shown in the Plans or ordered by the Engineer, the existing signs and, if so indicated, the sign structures shall be removed by the Contractor. Where indicated, the Contractor shall remove concrete pedestals to a minimum of 0.5 meter below subgrade or finished ground elevation and backfill the hole to the satisfaction of the Engineer. Where

an existing sign post is located within a sidewalk area, the Contractor shall remove the post and finish the area so as to make the sidewalk continuous. Aluminum signs, wood signs, wood sign posts, wood structures, metal sign posts, windbeams, and other metal structrual members shall become the property of the Contractor and shall be removed from the project. Salvage value of the removed signs and sign structure members shall be reflected in the Contractor's bid price for other items of work.

8-21.3(5) Sign Relocation

Where shown in the Plans or as directed by the Engineer, the existing signs and, if so indicated, the sign structures shall be relocated by the Contractor to the location noted. Where the existing sign structure is mounted on concrete pedestals, the Contractor shall remove the pedestal to a minimum of 300 millimeters below finished grade and backfill the remaining hole with material similar to that surrounding the hole. Where the existing structure is to be relocated, the Contractor shall provide necessary materials, labor, and hardware, and if so indicated, electrical conduit, conductors, etc., electrical services, and connections so as to erect and provide an operable unit to the satisfaction of the Engineer. All materials damaged by the Contractor shall be replaced at no cost to the Contracting Agency. Unless otherwise allowed, relocation of each existing sign and structure shall be accomplished during the day in which it was removed. Relocation of overhead signs and structures shall be accomplished during the hours between 12 midnight and 4:00 a.m. or as approved by the Engineer.

8-21.3(6) Sign Refacing

Where indicated in the Plans or in the Special Provisions, the Contractor shall reface existing signs with sheet aluminum overlay panels. Unless otherwise indicated in the Plans or allowed by the Engineer, all work shall be accomplished while the existing sign is in place. Modifications to each sign shall be completed during the same day in which the work is commenced.

Prior to the installation of overlay panels, the existing legend (message and border) shall be removed. The aluminum overlay panels shall be butt jointed. Aluminum or stainless steel screws, a minimum of 13 millimeters in length, shall be used to attach overlay panels to existing plywood signs. In addition to the screws, two 6-millimeter diameter by 25-millimeter-long aluminum or stainless steel bolts shall be installed through the top of each panel and the plywood sign. Aluminum blind rivets shall be used to attach overlay panels to existing aluminum signs. Screws or rivets shall be installed at 600-millimeter centers. Unless otherwise noted, sign background material shall be in accordance with Section 9-28.

After installation of overlay panels, the existing legend shall be reinstalled or, where indicated in the Plans, new legend or portions thereof shall be furnished and installed by the Contractor. Direct applied legend shall be applied to the new face prior to resurfacing. Layout and letter spacing shall be in accordance with Contracting Agency standards unless otherwise approved by the Engineer. New legend components shall be of the same type and size as the existing materials, and it shall be the Contractor's responsibility to verify material type and size. Materials damaged by the Contractor shall be replaced at no expense to the Contracting Agency.

8-21.3(7) Sign Message Revision

Where indicated in the Plans or in the Special Provisions, the Contractor shall revise existing sign messages or layouts. The Contractor shall remove and reinstall portions of or all of the existing message or furnish and install new message components as necessary to provide the revised message as indicated. Prior to installing the revised message, the Contractor shall thoroughly clean the sign face and plug all existing rivet holes with aluminum blind rivets painted the same color as the sign background. Plugging screw holes in plywood signs will not be required. Modifications to the sign shall be completed during the same day in which work is commenced and while the sign is in place. All new materials necessary to accomplish this work shall be the same type and size as the existing components, and it shall be the Contractor's responsibility to verify such component type and size. Materials damaged by the Contractor shall be replaced at no expense to the Contracting Agency. Existing materials not reinstalled shall become the property of the Contractor and shall be removed from the project.

8-21.3(8) Sign Cleaning

Signs shall be cleaned after relocation or installation to the satisfaction of the Engineer. The Contractor shall not use cleaning solvents that would be harmful to the sign finish.

8-21.3(9) Sign Structures

8-21.3(9)A Fabrication of Steel Structures

Fabrication and erection shall conform to the applicable requirements of Sections 6-03 and 9-06. Unless otherwise specified in the Plans or Special Provisions, metal surfaces shall not be painted.

8-21.3(9)B Grout

Grout shall conform to the requirements of Section 6-03.3(20).

8-21.3(9)C Timber Posts

Timber sign posts shall conform to the requirements of Section 9-28.14(1).

8-21.3(9)D Aluminum Structures

Welding of aluminum shall be in accordance with Section 9-28.14(3).

8-21.3(9)E Bridge Mounted Sign Brackets

The Contractor shall fabricate and install sign supports for mounting signs on bridge structures at the locations and as shown in the Plans, including inserts and anchor bolts. Fabrication and installation shall be in accordance with applicable requirements of Sections 6-03 and 9-06. Metal surfaces shall not be painted.

The quantity of structural carbon steel shown in the contract is listed only for the convenience of the Contractor in determining the volume of work involved and is not guaranteed to be accurate. The prospective bidders shall verify this quantity before submitting a bid. No adjustments other than for approved changes will be made in the lump sum contract price for the bridge mounted sign brackets, even though the actual quantity of structural carbon steel required may deviate from that listed.

8-21.3(9)F Bases

Sign structures shall not be erected on concrete foundations until foundations have attained a compressive strength of 16,500 kPa.

The excavation and backfill shall be in conformance with the applicable requirements of Section 2-09.

Foundation concrete shall conform to the requirements for the specified class, be cast-in-place concrete and be constructed in accordance with Section 6-02.2 and 6-02.3. Concrete for roadside sign structure post shall be Class 20, concrete for sign bridge and cantilever sign structure foundations shall be Class 28, except as otherwise specified. Where water is present in the shaft excavations for Type 1 foundations for sign bridges and cantilever sign structures, the shaft concrete shall be Class 28W.

Spiral steel reinforcing bars for roadside sign structures post shall conform to AASHTO M32. All other steel reinforcing bars for sign structure foundations shall conform to Section 9-07.

The bottom of concrete foundations shall rest on firm ground.

Foundations shall be cast in one operation where practicable. The exposed portions shall be formed to present a neat appearance.

The foundations shown in the Plans shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for as extra work as provided in Section 1-04.4.

Forms shall be true to line and grade. Tops of foundations for roadside sign structures shall be finished to ground line, unless otherwise shown in the Plans or directed by the Engineer. Tops of foundations for sign bridges and cantilever sign structures shall be finished to the elevation shown in the Plans or as directed by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be plumbed and rigidly placed in proper position and to proper height prior to placing concrete and shall be held in place by means of a template until the forms are removed.

All bolts and anchor bolts shall be installed so that two full threads extend beyond the top of the top heavy-hex nut. Anchor bolts shall be installed plumb, plus or minus 1 degree.

Plumbing of sign bridges and cantilever sign structures shall be accomplished by adjusting leveling nuts. Shims or other similar devices for plumbing or raking will not be permitted. After erecting the sign bridge or cantilever sign structure and prior to placing the grout pad, the portion of the anchor bolts above the foundation shall be coated with a heavy body corrosion resistant grease as approved by the Engineer.

Slip base and hinge connection nuts of roadside sign structures shall be tightened using a torque wrench to the torque, and following the procedure, specified in the Standard Plans.

The top heavy-hex nuts of sign bridges and cantilever sign structures shall be tightened in accordance with Section 6-03.3(33), and as follows:

The top heavy-hex nuts shall be tightened by the Turn-Of-Nut Tightening Method to minimum rotation of 1/4 turn and a maximum rotation of 1/3 turn past snug tight. Permanent marks shall be set on the base plate and nuts to indicate nut rotation past snug tight.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete; however, excess water in the foundation excavation will not be permitted. Forms shall not be removed until the concrete has set at least three days.

Class 2 surface finish shall be applied to exposed surfaces of concrete in accordance with the requirements of Section 6-02.3(14)B.

Where obstructions prevent construction of planned foundations, the Contractor shall construct an effective foundation satisfactory to the Engineer.

8-21.3(9)G Identification Plates

When sign structures are constructed, the Contractor shall attach sign structure identification plates to the sign structures as directed by the Engineer. The identification plates will be supplied by the Engineer. When sign structures are removed, the Contractor shall remove the sign structure identification plates from the sign structures and give them to the Engineer.

8-21.3(10) Sign Lighting

Where indicated in the Plans, the Contractor shall furnish and install external sign illumination equipment. Sign illumination equipment shall include fixtures, brackets, conduit, electrical wire, and other material required to make the sign lighting system operable. The Contractor shall intercept electrical conductors and make approved conductor splices at the nearest junction box or other source of power as noted in the Plans. The Contractor shall demonstrate to the Engineer the complete and satisfactory operation of each and every lighting fixture used for sign illumination.

8-21.3(10)A Sign Lighting Luminaires

Sign lighting luminaires shall meet the requirements of Section 9-28.15.

The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the Plans. If the sign structure includes a maintenance walkway, the luminaire fixture mounting plate shall be bolted to the walkway grating.

An isolation switch shall be provided in the line side conductors, mounted over the shoulder to de-energize all luminaires for maintenance purposes. The switch shall be single pole, single throw, or double-pole, single throw as necessary to open all conductors to the luminaires other than neutral and ground conductors. The switch shall contain 600 volt terminal strips on the load side with solderless box lugs as required plus four spare lugs per strip. The switch enclosure shall be rated NEMA 3 or better.

Conductors between the junction box or other source of power and the sign luminaire shall be code sized and the insulation shall be cross linked polyethylene type USE.

8-21.3(11) Multiple Panel Signs

After installation of multiple panel signs, the Contractor shall furnish and install an approved reinforced aluminized tape on the reverse side of the sign to prevent visible light through the seam. The tape shall be pressure sensitive and a minimum of 50 millimeters wide and 50 micrometers thick. In lieu of tape, the Contractor may use 25-millimeter-wide aluminum sheeting riveted to the sign back. The aluminum shall be a minimum of 0.8 millimeter thick. Rivet heads shall match the sign face color.

8-21.3(12) Steel Sign Posts

Steel sign posts shall be connected to concrete bases using the following procedure:

1. Remove all galvanized runs and beads from washer area.
2. Assemble sign post to stub post with bolts, using one flat washer on each bolt between plates.
3. Shim as required to plumb sign posts.
4. Tighten bolts in a systematic order to required torque while not over tightening.

5. Loosen each bolt and retighten to required torque in the same order as initial tightening.
6. After Contracting Agency inspection of bolt torque, burr threads with center punch to prevent loosening.

8-21.4 Measurement

When shown as lump sum in the Plans or in the proposal as permanent signing, sign bridge No. ____, cantilever sign structure No. ____ or bridge mounted sign bracket No. ____, no specific unit of measurement will apply, but measurement will be for the sum total of all items to be furnished and installed.

Sign covering will be measured in square meters of the area of the sign covered.

8-21.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Permanent Signing", lump sum.
"Sign Bridge No. ____", lump sum.
"Cantilever Sign Structure No. ____", lump sum.
"Bridge Mounted Sign Bracket No. ____", lump sum.
"Sign Covering", per square meter.

8-22 PAVEMENT MARKING

8-22.1 Description

This work shall consist of furnishing, installing, and removing pavement markings upon the roadway surface in accordance with the Plans, Standard Plans, and these Specifications, at locations shown in the Contract or as directed by the Engineer.

Pavement markings are defined as follows:

Skip Center Stripe

A BROKEN YELLOW line 100 millimeters wide. The broken or "skip" pattern shall be based on a 12.2-meter unit consisting of a 3-meter line and a 9.2-meter gap. Skip center stripe is used as center line delineation on two lane or three lane, two way highways.

Double Yellow Center Stripe

Two SOLID YELLOW lines, each 100 millimeters wide, separated by a 100-millimeter or 300-millimeter space. Double yellow center stripe is used as center line delineation on multilane, two way highways and for channelization.

Edge Stripe

A SOLID line, 100 millimeters wide, used on the edges of the traveled way. Edge stripes shall be WHITE except that on roadways with one way travel, the left edge stripe in the direction of travel shall be YELLOW.

Dotted Extension Stripe

A BROKEN LINE, 100 millimeters wide used to guide vehicles through an interchange or intersection. The broken pattern will be based on a 1.5-meter pattern consisting of a 0.5-meter line and a 1-meter gap. Dotted extension stripe shall be the same color as the line it is extending.

Gore Stripe

A SOLID WHITE line, 200 millimeters wide, used for delineation at ramp connections, to separate left and right turning movements from through movements, to separate high occupancy vehicle lanes from general purpose lanes, for islands, hash marks, and other applications.

Dotted Gore Stripe

A BROKEN WHITE line, 200 millimeters wide, used for high occupancy vehicle lane applications on arterials. The broken line pattern will be based on a 600-millimeter marking with a 1-meter gap.

Skip Gore Stripe

A BROKEN WHITE line, 200 millimeters wide, used for high occupancy vehicle lane applications on freeways. The broken line pattern will consist of a 3-meter marking with a 9.2-meter gap.

Lane Stripe

A BROKEN WHITE line, 100 millimeters wide, used to delineate adjacent lanes traveling in the same direction. The broken or "skip" pattern shall be based on a 12.2-meter unit consisting of a 3-meter line and a 9.2-meter gap.

Drop Lane Stripe

A BROKEN WHITE line, 200 millimeters wide, used to delineate a lane that ends at an off ramp. The broken or "skip" pattern shall be based on a 5-meter unit consisting of a 1-meter line and a 4-meter gap.

No-Pass Stripe

A SOLID YELLOW line, 100 millimeters wide, separated from a skip center stripe by a 100-millimeter space where passing is prohibited from the lane bounded by the no-pass stripe. Where passing is prohibited in both directions, no-pass stripes shall be two SOLID YELLOW lines, each 100 millimeters wide, separated by a 100-millimeter or 300-millimeter space.

Reversible Lane Stripe

Two BROKEN YELLOW lines, each 100 millimeters wide, separated by a 100-millimeter space. The broken or "skip" pattern shall be based on a 12.2-meter unit consisting of a 3-meter line and a 9.2-meter gap.

Two Way Left Turn Stripe

A SOLID YELLOW line, 100 millimeters wide, with a BROKEN YELLOW line, 100 millimeters wide, separated by a 100-millimeter space. The broken or "skip" pattern shall be based on a 12.2-meter unit consisting of a 3-meter line and a 9.2-meter space. The solid line shall be installed to the right of the broken line in the direction of travel.

Barrier Stripe

A SOLID YELLOW line, 460 millimeters wide unless noted otherwise in the Contract.

Crosswalk Stripe

A SOLID WHITE line, 300 millimeters wide, installed parallel to another crosswalk stripe with a 2-meter space between the lines, or a SOLID WHITE line 600 millimeters wide and 2.5 meters long conforming to details in the contract.

Stop Bar

A SOLID WHITE line, 450 millimeters wide unless noted otherwise in the Contract.

Traffic Arrow

A WHITE marking conforming to details in the Contract.

Traffic Letter

A WHITE marking conforming to the FHWA publication *Standard Alphabet for Highway Signs and Pavement Markings* for proportion.

With the exception of the traffic letters forming parts of the railroad crossing symbol, all traffic letters shall be 2.5 meters high.

Handicapped Parking Stall Symbol

A WHITE marking conforming to details in the Contract.

Preferential Lane Symbol

A WHITE marking conforming to details in the Contract.

Railroad Crossing Symbol

A WHITE marking conforming to details in the Contract. The letters included in the railroad crossing symbol shall conform to the FHWA publication *Standard Alphabet for Highway Signs and Pavement Markings* for proportion.

Cycle Detector Symbol

A WHITE marking conforming to details in the Contract.

Drainage Marking

A WHITE marking consisting of a 100-millimeter by 300-millimeter strip of plastic pavement marking material placed at the location of a cross-culvert, 300 millimeters outside the pavement edge stripe, with the 300-millimeter length parallel to the longitudinal axis of the pipe.

Aerial Surveillance Marker

A WHITE marking conforming to details in the Standard Plans.

8-22.2 Materials

Material for pavement marking shall be paint or plastic as noted in the bid item and selected from approved materials listed in the Qualified Products List. Paint and sprayed or extruded plastic material shall be applied with a top dressing of glass beads.

Paint shall comply with the specifications for no heat, instant dry pavement marking. Beads shall comply with the specifications for adherence coated glass spheres. Copies of paint and bead specifications are available at the Field Operations Support Service Center Materials Laboratory, 1655 South Second, Tumwater, Washington 98502.

All preformed tape and extrusion applied plastic pavement marking materials shall contain intermixed glass beads and shall have a skid resistance of 45 minimum British Pendulum Number (BPN). The skid resistance will be determined using ASTM Test Method D4505.

8-22.3 Construction Requirements

8-22.3(1) Preliminary Spotting

The Engineer will provide necessary control points at intervals agreed upon with the Contractor to assist in preliminary spotting of the lines before marking begins. The Contractor shall be responsible for preliminary spotting of the lines to be marked. Approval by the Engineer is required before marking begins. Preliminary spotting to guide the striping machine is required for all longitudinal lines except where a clearly visible separation is present.

8-22.3(2) Preparation of Roadway Surfaces

All contaminants within the areas to receive plastic markings shall be removed. When required by the Engineer, all contaminants within the areas to receive paint markings shall be removed. Large areas of tar, grease, or foreign materials may require sandblasting, steam cleaning, or power brooming to accomplish complete removal.

8-22.3(3) Paint Application

Two applications of paint will be required to complete all paint stripe markings. The time period between paint applications will vary depending on the type of pavement as follows:

Pavement Type	Time Period
Bituminous Surface Treatment	4 hours min., 48 hours max.
Asphalt Concrete Pavement	4 hours min., 30 days max.
Cement Concrete Pavement	4 hours min., 30 days max.

Where paint is applied on centerline on two-way roads with bituminous surface treatment, the second paint application shall be applied in the opposite direction as the first application.

The first application of paint shall be applied at a rate of not more than 4 square meters per liter (approximately 250 micrometers wet thickness). This rate is effectively 25 liters per kilometer of SOLID 100-millimeter-wide line which will be the basis for measurement of yield.

The second application of the paint shall be applied at a rate of not more than 3 square meters per liter (approximately 380 micrometers wet thickness). This rate is effectively 40 liters of paint per kilometer of SOLID 100-millimeter-wide line, which will be the basis of measurement of yield.

8-22.3(4) Beading

All liquid applied pavement markings shall be top dressed with glass beads. The application rate on spray applied markings shall be 0.8 kilograms minimum of beads per liter of material. The application rate on extrusion applied markings shall be 0.6 kilograms minimum per square meter. The bead application system shall provide a uniform bead distribution over the entire surface of the marking. Beads shall be applied to the material while in the semiliquid state on the roadway. Beads shall be applied to spray applied markings at the same time the paint is applied to the roadway.

If reflectivity appears to be inadequate, the markings will be evaluated by the contracting agency. All pavement markings shall provide an average minimum retroreflectivity reading of 250 millicandelas per lux per square meter for white markings and 200 millicandelas per lux per square meter for yellow markings when measured with a Mirolux 12 retroreflectometer. Measurements will be taken at least two days after, but not longer than 90 days after the application is complete on a section. A minimum of 20 readings will be recorded and averaged to determine if the minimum average retroreflectivity is met. Averages will be determined separately by line type and color. If reflectivity is found to be inadequate, the Contractor shall replace or repair the making to the satisfaction of the Engineer.

8-22.3(5) Tolerances for Line Stripes

Allowable tolerances for stripes are as follows:

Length of Stripe: The longitudinal accumulative error within a 9.2-meter length of skip stripe shall not exceed plus or minus 25 millimeters.

Width of Stripe: The width of stripe shall not vary more than plus or minus 6 millimeters.

Lane Width: The lane width, which is defined as the lateral width from the edge of pavement to the center of the lane line or between the centers of successive lane lines, shall not vary from the widths shown in the Contract by more than plus or minus 100 millimeters.

Film Thickness: A film thickness tolerance not exceeding 10 percent will be allowed for thickness or yield in paint application.

8-22.3(6) Installation Instructions

Installation instructions for plastic markings shall be provided for both the Contractor and the Engineer. All materials shall be installed according to the manufacturer's recommendations and a manufacturer's technical representative shall be present at the initial material installation to approve the installation procedure.

8-22.3(7) Removal of Pavement Markings

Pavement markings to be removed shall be obliterated until blemishes caused by the pavement marking removal conform to the coloration of the adjacent pavement. If, in the opinion of the Engineer, the pavement is materially damaged by pavement marking removal, such damage shall be repaired by the Contractor in accordance with Section 1-07.13(1). Sand or other material deposited on the pavement as a result of removing stripes and markings shall be removed as the work progresses to avoid hazardous conditions. Accumulation of sand or other material which might interfere with drainage will not be permitted.

8-22.4 Measurement

Skip center stripe, skip center stripe with no pass stripe, double yellow center stripe, edge stripe, dotted extension stripe, lane stripe, double no-pass stripe, reversible lane stripe, and two-way left-turn stripe will be measured by the completed meter as "Paint Stripe" or "Plastic Stripe."

The measurement for "Paint Stripe" will be based on a marking system capable of simultaneous application of three 100-millimeter lines with two 100-millimeter spaces. No deduction will be made for the unmarked area when the marking includes a skip line such as skip center stripe, skip center stripe with no-pass stripe, lane stripe, reversible lane stripe, or two-way left-turn stripe. No additional measurement will be allowed when more than one line can be installed on a single pass such as skip center stripe with no-pass stripe, double yellow center stripe, double no-pass stripe, reversible lane stripe, or two-way left-turn stripe.

The measurement for "Plastic Stripe" will be based on the total length of each 100 millimeter wide plastic stripe installed. No deduction will be made for the unmarked area when the marking includes a skip line, such as skip center stripe, skip center stripe with no-pass stripe, lane stripe, reversible lane stripe, or two-way left-turn stripe.

Gore stripe, dotted gore stripe, skip gore stripe, drop lane stripe, barrier stripe, and stop bar will be measured by the completed meter of each marking type. No deduction will be made for the unmarked area when the marking includes a gap such as dotted gore stripe, skip gore stripe, or drop lane stripe.

Crosswalk stripe will be measured by the square meter of marking installed.

Traffic arrows will be measured by the unit with each arrow head defined as a unit. Type 1, 2, and 5 arrows are considered one unit each. Type 3 and 4 arrows are considered two units each.

Traffic letters, handicapped parking stall symbols, preferential lane symbols, railroad crossing symbols, drainage markings, cycle detector symbols, aerial surveillance full marker, and aerial surveillance 1/2 marker will be measured by the unit.

Removal of the stripes 100 millimeters or less in width will be measured by the actual meter removed, with no deduction being made for the unmarked area of the skip pattern in center stripes and lane stripes. Removal of traffic markings or stripes in excess of 100 millimeters in width will be measured by the square meter for the area actually removed.

Removal of traffic arrows and traffic letters will be measured by the unit per each.

8-22.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Paint Stripe", per meter.
"Plastic Stripe", per meter.
"Painted Drop Lane Stripe", per meter.
"Plastic Drop Lane Stripe", per meter.
"Painted Gore Stripe", per meter.
"Plastic Gore Stripe", per meter.
"Painted Dotted Gore Stripe", per meter.
"Plastic Dotted Gore Stripe", per meter.
"Painted Skip Gore Stripe", per meter.
"Plastic Skip Gore Stripe", per meter.
"Painted Barrier Stripe", per meter.
"Plastic Barrier Stripe", per meter.
"Painted Crosswalk Stripe", per square meter.
"Plastic Crosswalk Stripe", per square meter.
"Painted Stop Bar", per meter.
"Plastic Stop Bar", per meter.
"Painted Traffic Arrow", per each.
"Plastic Traffic Arrow", per each.
"Painted Traffic Letter", per each.
"Plastic Traffic Letter", per each.
"Painted Handicapped Parking Stall Symbol", per each.
"Painted Preferential Lane Symbol Type ____", per each.
"Plastic Preferential Lane Symbol Type ____", per each.
"Painted Railroad Crossing Symbol", per each.
"Plastic Railroad Crossing Symbol", per each.
"Painted Cycle Detector Symbol", per each.
"Plastic Drainage Marking", per each.
"Painted Aerial Surveillance Full Marker", per each.
"Plastic Aerial Surveillance Full Marker", per each.
"Painted Aerial Surveillance 1/2 Marker", per each.
"Plastic Aerial Surveillance 1/2 Marker", per each.
"Removing Paint Stripe", per meter.
"Removing Plastic Stripe", per meter.
"Removing Painted Traffic Marking", per square meter.
"Removing Plastic Traffic Marking", per square meter.
"Removing Painted Traffic Arrow", per each.
"Removing Plastic Traffic Arrow", per each.
"Removing Painted Traffic Letter", per each.
"Removing Plastic Traffic Letter", per each.

8-23 TEMPORARY PAVEMENT MARKINGS

8-23.1 Description

The work shall consist of furnishing and installing temporary pavement markings. Temporary pavement markings shall be provided where noted in the Plans and for all lane shifts and detours resulting from construction activities. Temporary pavement markings shall also be provided when permanent markings are eliminated because of construction operations. Temporary pavement markings shall be maintained in serviceable condition throughout the project until permanent pavement markings are installed. Temporary pavement markings that are damaged shall be repaired or replaced immediately. Edge lines shall be installed only if specifically required in the contract. Temporary pavement marking installations are defined as follows:

Temporary Center Stripe

A BROKEN line used to delineate adjacent lanes of traffic moving in opposite directions. The broken or "skip" pattern shall be based on a 12-meter unit, consisting of a 1.25-meter line with a 10.75-meter gap if paint or tape is used. If temporary raised pavement markers are used, the pattern shall be based on a 12-meter unit, consisting of a grouping of three temporary raised pavement markers, each spaced 1 meter apart, with a 10-meter gap.

Temporary Edge Stripe

A SOLID line used on the edges of traveled way. The line shall be continuous if paint or tape is used. If temporary raised pavement markers are used, the line shall consist of markers installed continuously at 1.5-meter spacings.

Temporary Lane Stripe

A BROKEN line used to delineate adjacent lanes with traffic traveling in the same direction. The broken or "skip" pattern shall be based on a 12-meter unit, consisting of a 1.25-meter line with a 10.75-meter gap, if paint or tape is used. If temporary raised pavement markers are used, the pattern shall be based on a 12-meter unit, consisting of a grouping of three temporary raised pavement markers, each spaced 1 meter apart, with a 10-meter gap.

8-23.2 Materials

Materials for temporary markings shall be paint, tape, or raised pavement markers. All temporary markings shall be 100 millimeters wide. Lane stripe and right edge stripe shall be white in color. Center stripe and left edge stripe shall be yellow in color. All temporary pavement markings shall be retroreflective.

Temporary flexible raised pavement markers shall consist of an L-shaped body with retroreflective tape on the top of one face for one-way traffic and reflective tape on the top of both faces for two-way traffic. The marker body shall be made from 1.5 millimeters minimum thick polyurethane. The top of the vertical leg shall be between 40 millimeters and 55 millimeters high and shall be approximately 100 millimeters wide. The base width shall be approximately 2.8 millimeters wide. The base shall have a pressure sensitive adhesive material, a minimum of 3 millimeters thick with release paper. The reflective tape shall be a minimum of 6 millimeters high by 100 millimeters wide. The reflective tape shall have a minimum reflectance of 0.28 candlepower per lux for white and 0.23 candlepower

per lux for yellow measured at 0.2° observation angle and 0° entrance angle. When temporary flexible raised pavement markers are used for bituminous surface treatment operations, the markers shall be supplied with a protective cover made of clear polyvinyl chloride. The cover shall be removed after spraying asphaltic material.

Temporary raised pavement markers other than temporary flexible raised pavement markers shall conform to the requirements of Section 8-09.2.

Paint used for temporary pavement marking shall conform to the requirements noted in Section 8-22.2 and shall be applied in one application at a rate of 2.5 square meters per liter (approximately 380 micrometers wet thickness).

Temporary pavement marking tape shall be pressure sensitive, reflective type, conforming to ASTM D 4592, designed for application on asphalt or concrete pavement. Biodegradable tape with paper backing will not be allowed. Surface preparation and application shall be in conformance with all the manufacturer's recommendations.

Material for temporary pavement markings shall be selected from approved materials listed in the Qualified Products List.

8-23.3 Construction Requirements

8-23.3(1) Preliminary Spotting and Removal

All preliminary layout and marking in preparation for application and the application and removal of temporary pavement markings shall be the responsibility of the Contractor.

Temporary flexible raised pavement markers are required for bituminous surface treatment operations.

Temporary pavement markings consisting of paint or tape may be paved over, but temporary raised pavement markers or removable tape stripe shall be removed prior to paving.

Any temporary pavement markings which are required on the wearing course prior to construction of permanent pavement markings and are not a part of the permanent markings shall be completely removed concurrent with or immediately subsequent to the construction of the permanent pavement markings. Temporary flexible raised pavement markers on bituminous surface treatment pavements shall be cut off flush with the surface if their location conflicts with the alignment of the permanent pavement markings.

All damage to the permanent work caused by removing temporary pavement markings shall be repaired by the contractor at no additional cost to the contracting agency.

8-23.3(2) Beading and Tolerances

Beading shall be in accordance with Section 8-22.3(4). Striping tolerances shall be in accordance with Section 8-22.3(5).

8-23.4 Measurement

Temporary center stripe, temporary edge stripe, temporary lane stripe, and temporary raised pavement markers will be measured by the meter of each installed stripe or grouping of markers, with no deduction for gaps in the stripe or markers.

Removing temporary center stripe, temporary edge stripe, temporary lane stripe, and temporary raised pavement markers will be measured by the meter of each stripe or grouping of markers removed, with no deduction for gaps in the stripe or markers.

8-23.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the Proposal:

"Temporary Pavement Marking," per meter.

The unit contract price per meter for "Temporary Pavement Marking" shall be full pay for constructing and maintaining temporary striping and markers as specified. Unless a bid item has been included in the proposal to pay for removal of temporary pavement markings, all costs for removal of temporary pavement markings shall be included in the unit contract price per meter for "Temporary Pavement Marking." No additional compensation will be allowed when the Contractor is required to repair or replace temporary markings that have been damaged.

"Removing Temporary Pavement Marking," per meter.

8-24 ROCK WALL

8-24.1 Description

This work shall consist of constructing rock wall(s) in accordance with the Plans, Special Provisions, these Specifications, or as designated by the Engineer.

8-24.2 Materials

Materials shall meet the requirements of the following Sections:

Rock for Rock Wall and Chinking Material	9-13.7(1)
Backfill for Rock Wall	9-13.7(2)
Construction Geotextile	9-33

8-24.3 Construction Requirements

8-24.3(1) Quality Assurance

The completed wall shall meet the following tolerances:

1. Wall batter shall be 1:6 or flatter as specified in the Plans.
2. The exterior slope plane and grade in the finished surface of the wall shall be plus or minus 150 mm.
3. The maximum void between adjacent rocks shall be 150 mm as measured at the smallest dimension of the void within the thickness of the wall.

8-24.3(2) Excavation

Excavation shall be in accordance with the requirements of Section 2-09 and in conformity to the limits and construction stages shown in the Plans.

The Contractor shall restrict the excavation limits to the length of rock wall that can be constructed in one day's work. Excavation beyond the limits that can be completed in one day's work shall be permitted if the Contractor can demonstrate that the excavation will remain stable until the rock wall is completed.

Slopes above the rock wall shall be established prior to excavating for the wall.

8-24.3(3) Foundation Preparation

The foundation for the wall shall be graded as shown in the Plans.

Prior to rock placement, the foundation, if not in rock, shall be compacted as approved by the Engineer. Any foundation soils found to be unsuitable shall be removed and replaced as provided for under Section 2-09.3(1)C.

Base course rocks shall have full contact with the foundation soils. If necessary, the excavation shall be shaped to fit the rocks. Rocks may be dropped to shape the ground provided the rocks do not crack. Cracked rocks shall be replaced and the foundation regraded to fit the replacement rock.

8-24.3(4) Construction Geotextile

Construction Geotextile shall be as shown in the Plans and shall conform to Section 9-33.

8-24.3(5) Rock Placement and Backfill

Rocks shall be placed so there are no continuous joint planes in either the vertical or lateral direction.

Where possible, rocks shall be placed so that the rock shall bear on at least two rocks below it. Rocks shall be oriented so that flat surface contact points between adjacent rocks are maximized. Point-to-point contact between adjacent rocks shall be minimized. Each rock in a course shall be arranged so that the natural irregularities in the rocks key the rocks together and so that the courses are keyed together.

Rocks shall increase in size from the top of the wall to the bottom at a uniform rate. The minimum rock sizes, as referenced from the top of the wall, shall be as follows:

Depth from Top of Wall (m)	Minimum Rock Size at Depth from Top of Wall
1.7	Three man
2.7	Four Man
3.7	Five man

Rocks at the top of the wall shall be Two Man or larger.

Where voids larger than 150 mm are present, chinking rock shall be keyed between the rocks to fill the void.

Backfill for the rock wall shall be placed behind each course and tamped to provide a stable condition prior to placing rocks for the next successive course. Backfill shall be shot rock in accordance with Section 9-13.7(2).

For rock walls constructed in fills, the fill shall be overbuilt and cut back to construct the wall.

8-24.4 Measurement

Rock for rock walls and backfill for rock walls will be measured by the tonne of rock actually placed.

Construction Geotextile will be measured by the square meter for the surface area actually covered.

Structure Excavation Class B shall be in accordance with Section 2-09.4.

8-24.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items that are included in the proposal:

“Rock for Rock Wall”, per tonne.

The unit contract price per tonne for “Rock for Rock Wall” shall also include furnishing and installing chinking materials.

“Backfill for Rock Wall”, per tonne.

“Construction Geotextile”, per square meter.

“Structure Excavation Class B”, per cubic meter.

8-25 GLARE SCREEN

8-25.1 Description

This work shall consist of furnishing and constructing glare screen of the types specified, in accordance with the Plans, these Specifications, the Standard Plans, and as directed by the Engineer.

Glare screen consists of diamond woven wire mesh fence of aluminum, galvanized or aluminum coated steel wire, fabricated and placed to reduce glare from headlights of opposing traffic or other adjacent light sources.

8-25.2 Materials

Materials shall meet the requirements of Section 9-16.6.

8-25.3 Construction Requirements

8-25.3(1) Glare Screen Fabric

Glare screen fabric shall be placed on the face of the posts designated by the Engineer. On curves the fabric shall be placed on the face of the post which is on the outside of the curve.

The fabric shall be stretched taut and securely fastened to the posts. Fastening to end, brace, and pull posts shall be with stretcher bars and fabric bands spaced at 300 millimeter intervals. The fabric shall be cut and each span attached independently at all pull and corner posts. Fabric shall be securely fastened to line posts with tie wires, metal bands, or other approved methods, attached at 350-millimeter intervals. The top and bottom of the fabric shall be fastened to the tension cable and tension wire with hog rings spaced at 600-millimeter intervals.

Rolls of wire fabric shall be joined by weaving a single strand into the end of the rolls to form a continuous mesh.

8-25.3(2) Slats

The slats shall be fastened into the weave by using staples, screws, or other methods as approved by the Engineer. Allowing the tension of the mesh to hold the slats in place will not be permitted.

Slats broken or split during construction shall be removed and replaced by the Contractor at no expense to the Contracting Agency.

8-25.3(3) Posts

Posts, other than for Type 1 Design A, shall be constructed in accordance with the Standard Plans and applicable provisions of Section 8-12.3(1)A.

Posts for Type 1 Design A shall be bolted to the beam guardrail posts as detailed in the Standard Plans. Drilling of the guardrail posts shall be done in such a manner to ensure that the glare screen posts are set plumb and centered over the guardrail posts unless otherwise directed.

All round posts for Type 1 Design B and Type 2 glare screen shall be fitted with a watertight top securely fastened to the post. Line posts shall have tops designed to carry the top cable.

8-25.3(4) Tension Wire

Tension wires shall be attached to the posts as detailed in the Standard Plans or as approved by the Engineer.

8-25.3(5) Tension Cables

The tension cable shall pass through the line post top, and one continuous length of cable shall be used between the pull posts. Sufficient tension shall be applied to the cable to allow a maximum sag of 7 millimeters between posts after the chain link mesh has been attached to the cable. The Contractor shall provide temporary bracing on pull posts when applying tension to one length of cable at a time to prevent undue stresses on the pull post.

The cable shall be fastened to the top of the pull post with an eye bolt through the post and a turnbuckle connecting the eye bolt to the cable. Pull posts shall be braced to the bottom of the end or anchor posts with a short length of cable or tension wire as shown in the Standard Plans. All turnbuckles shall have a minimum of 25 millimeters takeup clearance after tensioning.

The ends of all cables shall be seized with annealed iron wire for a distance of at least 25 millimeters.

8-25.3(6) Fittings, Attachments and Hardware

A lead washer shall be placed against the shoulder of the eye nut, eye bolt, or backup nut, and a lead washer backed by the steel washer placed between the pipe and lock washer, and the nut tightened sufficiently to seal the hole in the pipe.

A galvanized iron strap 6.35 millimeters in thickness by 50 millimeters in width, formed as shown in the Standard Plans, shall be provided for the attachment of eye bolts to the base of the H column post in order to take the strain of the cable tension off the web of the H column.

8-25.4 Measurement

Measurement of glare screen will be by the meter of completed glare screen for the particular type and design specified.

8-25.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Glare Screen Type 1 Design ____", per meter.

"Glare Screen Type 2", per meter.

8-29 WIRE MESH SLOPE PROTECTION

8-29.1 Description

This work shall consist of constructing wire mesh slope protection in accordance with these Specifications and the details shown in the Standard Plans and in conformity with the lines and dimensions shown in the Plans or established by the Engineer.

8-29.2 Materials

Materials shall meet the requirements of Section 9-16.4.

8-29.3 Construction Requirements

8-29.3(1) Anchors

The Contractor shall install anchors of the type shown in conformance to the layout shown in the Plans. The spacing and number of the anchors and wire ropes as shown in the Plans are approximate only, and the Engineer will arrange the spacing in such a manner as to hold the wire mesh against the slope. Backfill material shall be thoroughly compacted.

8-29.3(2) Wire Rope Assembly

The wire rope assembly shall be in place before the wire mesh is attached. The bottom wire rope shall not be tensioned. No wire rope splicing will be allowed.

8-29.3(3) Wire Mesh

The wire mesh shall be fastened to the completed wire rope assembly as shown in the Plans and as directed by the Engineer. Hog rings on the vertical lap splices shall be placed in a single row centered on the splice. Horizontal splices joining two rolls of mesh shall be made by removing a horizontal end wire and reweaving through the ends of the fabric to form a continuous mesh. All top and bottom laps shall be made by folding the mesh to the outside, away from the slope, to avoid the possibility of falling material hanging up in the folds. The bottom of the mesh shall be located so that material dislodged under the mesh can drain freely from the bottom, yet will not flow or bounce onto the roadway. The ends of all tie wires shall be secured to the mesh with a minimum of $1^1/_2$ turns.

The wire mesh shall not be tensioned in any direction, but is to remain loose so as to increase its dampening effect on rolling rocks. The Contractor shall use care in the handling and installing of the wire mesh and wire rope. Any mesh or cable damaged due to the Contractor's operations shall be replaced by the Contractor at no expense to the Contracting Agency.

8-29.4 Measurement

Measurement of anchors will be per each for the completed anchor. Anchor types will not be differentiated.

Galvanized wire mesh will be measured by the square meter of the completed area.

Galvanized wire rope will be measured by the meter of wire rope actually used in the completed project.

8-29.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Wire Mesh Slope Protection Anchor", per each.

"Galvanized Wire Mesh", per square meter.

"Galvanized Wire Rope", per meter.

DIVISION 9
MATERIALS

9-00 DEFINITIONS AND TESTS

9-00.1 Fracture

"Fractured aggregate is defined as aggregate particles which have one or more fractured faces. A face will be counted as fractured whenever one-half or more of the projected area of the particle is comprised of a fractured face when viewed normal to the fractured face."

9-00.2 Wood Waste

Wood waste is defined as all material which, after drying to constant mass, has a specific gravity of less than 1.0.

9-00.3 Test for Mass of Galvanizing

At the option of the Engineer, the mass of zinc in kilograms per square meter required by the various galvanizing specifications may be determined by an approved magnetic thickness gage suitably checked and demonstrated for accuracy, in lieu of the other methods specified.

9-00.4 Sieve Analysis of Aggregates

Sieve analysis for acceptance of aggregate gradation shall be performed by procedures described in Field Operating Procedures for AASHTO T 11/T 27.

9-00.5 Dust Ratio

The dust ratio is defined as the percent of material passing the 0.075-millimeter sieve divided by the percent of material passing the 0.425-millimeter sieve.

9-00.6 Sand/Silt Ratio

The sand/silt ratio is defined as the percent of material passing the 2.00-millimeter sieve divided by the percent of material passing the 0.075-millimeter sieve.

9-00.7 Galvanized Hardware, AASHTO M 232

An acceptable alternate to hot-dip galvanizing in accordance with AASHTO M 232 will be zinc coatings mechanically deposited in accordance with AASHTO M 298, providing the minimum thickness of zinc coating is not less than that specified in AASHTO M 232, and the process will not produce hydrogen embrittlement in the base metal. Sampling and testing will be made by the Engineer in accordance with commonly recognized national standards and methods used in the laboratory of the Department of Transportation.

9-00.8 Sand Equivalent

The sand equivalent will be the average of duplicate determinations from a single sample. The sand equivalent sample will be prepared in accordance with the WSDOT Field Operating Procedure (FOP) for AASHTO T 176.

For acceptance of processed material there must be a clear line of demarcation. If no clear line of demarcation has formed at the end of the specified 20-minute sedimentation period, the material will be considered as failing to meet the minimum specified sand equivalent.

9-00.9 Field Test Procedures

Field test procedures may be either a WSDOT procedure or a Field Operating Procedure (FOP) for a AASHTO test procedure. A Field Operating Procedure is a technically equivalent abridged version of a AASHTO test procedure for use in field conditions.

9-01 PORTLAND CEMENT

9-01.1 Types of Cement

Cement shall be classified as Portland cement or blended hydraulic cement.

9-01.2 Specifications

9-01.2(1) Portland Cement

Portland cement shall conform to the requirements for Types I, II, or III cement of the Standard Specifications for Portland Cement, AASHTO M 85, except that the content of alkalis shall not exceed 0.75 percent by mass calculated as Na20 plus 0.658 K20.

Type II cement shall meet the requirements of the above specifications for compressive strength and for time of setting by the Vicat method, AASHTO T 131.

9-01.2(2) Vacant

9-01.2(3) Low Alkali Cement

When the Special Provisions state that low alkali cement shall be used, the percentage of alkalis in the cement shall not exceed 0.60 percent by mass calculated as Na20 plus 0.658 K20. This limitation shall apply to all types of Portland cement.

9-01.2(4) Blended Hydraulic Cement

Blended hydraulic cement shall conform to the requirements for Type IP (MS) or Type I (PM)(MS) cement of the Standard Specification for Blended Hydraulic Cements, AASHTO M 240 with the additional requirement that the maximum fly ash content shall be 25 percent of the cementitious material. The source of the fly ash, as well as the mass of fly ash as a percent by mass of total cement plus fly ash, shall be certified on the cement mill test certificate.

9-01.3 Tests and Acceptance

Cement may be accepted by the Engineer based on the Manufacturer's Mill Test Report number indicating full conformance to the Specifications. All shipments of the cement to the Contractor or concrete supplier shall identify the applicable Mill Test Report Number. The concrete supplier or Contractor shall provide mill test identification on all concrete deliveries.

Each mixing facility or plant utilizing Portland cement shall be equipped with a suitable means or device for obtaining a representative sample of the cement. The device shall enable the sample to be readily taken in proximity to the cement weigh hopper and from a container or conveyor holding only cement.

Cement may be tested using samples taken at the job site by the Engineer for submission to the Olympia Service Center Materials Laboratory for testing.

9-01.4 Storage on the Work Site

The cement shall be stored on the site in a manner as to permit easy access for inspection and identification.

Cement shall be adequately protected at all times from rain and dampness. Cement which, in the opinion of the Engineer, contains lumps that will not be pulverized in the mixer shall be rejected.

Type III Portland cement stored by the Contractor for a period longer than 30 days, or Types I or II Portland cement stored by the Contractor for a period longer than 60 days, shall be held for retest. If the cement has lost strength during the period of storage, as shown by tests of the Contracting Agency, sufficient additional cement shall be added to the mix at the Contractor's expense to overcome such loss, or the cement may be rejected. The amount of cement to be added to the mix shall be determined by the Engineer.

9-02 BITUMINOUS MATERIALS

9-02.1 Asphalt Material, General

Asphalt furnished under these Specifications shall not have been distilled at a temperature high enough to injure by burning or to produce flecks of carbonaceous matter, and upon arrival at the work, shall show no signs of separation into lighter and heavier components.

9-02.1(1) Vacant

9-02.1(2) Medium-Curing (MC) Liquid Asphalt

Characteristics		WSDOT Test Method	MC-70	MC-250	MC-800	MC-3000
Kinematic Viscosity at 60°C mm^2/s		202	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. °C	207	38	66	66	66
Water Content	Max. %	217	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate to 360°C		211				
to 225°C			0-20	0-10	---	---
to 260°C			20-60	15-55	0-35	0-15
to 315°C			65-90	60-87	45-80	15-75
Residue of 360°C distillation % volume by difference	Min.		55	67	75	80
Properties of residue from distillation to 360°C						
Absolute viscosity at 60°C, Pa·s		203	30.0-120.0	30.0-120.0	30.0-120.0	30.0-120.0
[1]Ductility, 5cm/min. at 25°C, cm	Min.	213	100	100	100	100
Solubility in trichloroethylene	Min. %	214	99.0	99.0	99.0	99.0

[1]If the ductility at 25°C is less than 100, the material will be acceptable if its ductility at 16°C is more than 100.

The material shall not foam when heated to the application temperature recommended in Section 5-02.3(3).

9-02.1(3) Rapid-Curing (RC) Liquid Asphalt

Characteristics		WSDOT Test Method	RC-70	RC-250	RC-800	RC-3000
Kinematic Viscosity at 60°C, mm^2/s		202	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. °C	207	---	27	27	27
Water Content	Max. %	217	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate to 360°C		211				
to 190°C	Min.		10	---	---	---
to 225°C	Min.		50	35	15	---
to 260°C	Min.		70	60	45	25
to 315°C	Min.		85	80	75	70
Residue of 360°C distillation % volume by difference	Min.		55	65	75	80
Properties of residue from distillation to 360°C						
Absolute viscosity at 60°C, Pa·s		203	60.0-240.0	60.0-240.0	60.0-240.0	60.0-240.0
Ductility, 5 cm/min. at 25°C cm	Min.	213	100	100	100	100
Solubility in trichloroethylene	Min. %	214	99.0	99.0	99.0	99.0

The material shall not foam when heated to application temperature recommended in Section 5-02.3(3).

9-02.1(4) Asphalt Cements

9-02.1(4)A Paving Asphalt

Characteristics	WSDOT Test Method	Viscosity Grade AR-4000W	AR-2000W
Tests on Residue from RTFC Procedure [note 1]	208		
Absolute Viscosity at 60°C, Pa·s	203	250.0-500.0	150.0-250.0
Kinematic Viscosity at 135°C mm^2/s, min.	202	275	200
Penetration at 25°C 100g/5 sec, min.	201	40	50
Percent of original penetration at 25°C min.	[note 2]	45	40
Ductility at 7.2°C (1 cm/min.) cm. min.	213	10	20

Characteristics	WSDOT Test Method	Viscosity Grade AR-4000W	AR-2000W
Test on Original Asphalt			
Flashpoint (Cleveland Open Cup) °C min.	206	227	218
Solubility in Trichloroethylene, % min.	214	99.0	99.0

note 1 TFO may be used but RTFC shall be the referee method.

note 2 Original penetration as well as penetration after RTFC loss will be determined by AASHTO T 49.

9-02.1(4)B Modified Paving Asphalt

	AASHTO Test Method	Specification PBA-6	Requirements PBA-6GR
Penetration (4°C, 200g, 60s), dmm			
RTFO Aged Residue note 2	T-49	30+	30+
Absolute Viscosity 60°C, Pa·s note 5			
Original Binder	T-202	200.0+	200.0+
RTFO Aged Residue	T-202	500.0+	500.0+
Kinematic Viscosity 135°C, mm²/s			
Original Binder	T-201	2000-	2000-
RTFO Aged Residue	T-201	275+	275+
Absolute Viscosity Ratio 60°C			
RTFO Viscosity/Original Viscosity		4.0-	4.0-
Flash Point, Cleveland Open Cup, °C			
Original Binder	T-48	232+	232+
Ductility (25°C, 5cm/min), cm			
RTFO Aged Residue	T-51	60+	____

PBA-6GR shall contain not less than 10 percent by mass of total material of powdered rubber meeting the requirements described below for sieve analysis and chemical properties.

Sieve Analysis

Sieve Size	Percent Passing
0.25 mm	99-100
0.18 mm	89-100
0.15 mm	74-90
0.075 mm	24-90

Chemical Properties

Acetone Extract (ASTM D 297) % max.	23
Ash (ASTM D 297B) % max.	7
Carbon Black (ASTM D 297B) % max.	34
Rubber Hydrocarbon (by difference) % max.	42
Specific Gravity (ASTM D 297)	1.15±0.02
Moisture Content % max.	1.0

note 2"RTFO Aged Residue" means the asphaltic residue obtained using the Rolling Thin-Film Oven Test (RTFO Test), AASHTO T 240 or ASTM D 2872.

note5The Absolute Viscosity (60°C) of PBA-6 and PBA-6GR will be determined at 1 sec $^{-1}$ using ASTM P 159 (Vol. 4.03, 1985) with Asphalt Institute Vacuum Capillary Viscometers.

9-02.1(5) Recycling Agent

Recycling agents shall conform to the following requirements:

	HOT Mix Recycling Agents[note 1]				
	ASTM Test	**RA 5**		**RA 25**	
Test	**Method**	**Min.**	**Max.**	**Min.**	**Max.**
Original Test					
Viscosity at 60°C, mm^2/s	D2170 or D2171	200	800	1,000	4,000
Flashpoint COC, °C	D92	204	---	218	---
Saturates, Wt. %	D2007	---	30	---	30
Specific Gravity	D70 or D1298	Report		Report	
Residue Test from RTFC	D2872[note 2]				
Viscosity Ratio[note 3]	---	---	3	---	3
Mass Change ± %	---	---	4	---	3

note 1The final acceptance of recycling agents meeting this specification is subject to the compliance of the reconstituted asphalt blends with current asphalt specifications.

note 2The use of ASTM D 1754 has not been studied in the context of this specification; however, it may be applicable. In cases of dispute, the reference method shall be ASTM D 2872.

note 3$$\text{Viscosity Ratio} = \frac{\text{RTFC Viscosity at } 60^\circ\text{C, mm}^2/\text{s}}{\text{Original Viscosity at } 60^\circ\text{C, mm}^2/\text{s}}$$

HOT Mix Recycling Agents[note 1]

Test	ASTM Test Method	RA 75 Min.	RA 75 Max.	RA 250 Min.	RA 250 Max.	RA 500 Min.	RA 500 Max.
Original Test Viscosity at 60°C, mm^2/s	D2170 or D2171	5,000	10,000	15,000	35,000	40,000	60,000
Flashpoint COC, °C	D92	232	---	232	---	232	---
Saturates, Wt. %	D2007	---	30	---	30	---	30
Specific Gravity	D70 or D1298	Report		Report		Report	
Residue Test from RTFC	D2872[note 2]						
Viscosity Ratio[note 3]		---	3	---	3	---	3
Mass Change ± %	---	---	2	---	2	---	2

[note 1]The final acceptance of recycling agents meeting this specification is subject to the compliance of the reconstituted asphalt blends with current asphalt specifications.

[note 2]The use of ASTM D 1754 has not been studied in the context of this specification; however, it may be applicable. In cases of dispute, the reference method shall be ASTM D 2872.

[note 3]$$\text{Viscosity Ratio} = \frac{\text{RTFC Viscosity at } 60^\circ\text{C, mm}^2/\text{s}}{\text{Original Viscosity at } 60^\circ\text{C, mm}^2/\text{s}}$$

9-02.1(6) Cationic Emulsified Asphalt

See table on page 9-11.

9-02.1(7) Asphalt for Sub-Sealing

Asphalt for sub-sealing shall conform to the requirements of AASHTO M 238 except that the minimum softening point shall be 77°C.

9-02.1(8) Hot Melt Traffic Button Adhesive

The bitumen adhesive material shall conform to the following requirements:

Specification	ASTM Test Method	Requirement
Flash Point, COC °C	D 92	288 Min.
Softening Point, °C	D 36	93 Min.
Brookfield Viscosity, 204°C	D 2196	7.5 Pa·s, Max.
Penetration, 100g, 5 sec, 25°C	D 5	10-20 dmm
Filler Content, % by mass (Insoluble in 1,1,1 Trichloroethane)	D 2371	50-75

Filler material shall be calcium carbonate and shall conform to the following fineness:

Sieve Size	Percent Passing
0.15 mm	100
0.075 mm	95
0.045 mm	75

Hot melt bitumen adhesive shall develop bond pull-off strength greater than 690 kPa between -18°C and 49°C.

9-02.1(9) Coal Tar Pitch Emulsion

Coal tar pitch emulsion shall conform to all requirements of Federal Specification R-P-355. The emulsion shall be prepared from straight run, high temperature, coke oven tar meeting the requirements of Federal Specification RC 1424. The emulsion shall be homogeneous and shall show no separation or coagulation of components that cannot be overcome by moderate stirring. It shall be capable of being applied completely by squeegee, brush, or other approved mechanical methods to the surface of bituminous pavements when spread at the specified rates.

9-02.2 Sampling and Acceptance

9-02.2(1) Certification of Shipment

Bituminous materials may be accepted by the Engineer based on the asphalt supplier's Certification of Compliance incorporated in their Bill of Lading. The Certification will include a statement certifying specification compliance for the product shipped. Failure to provide this Certification with the shipment shall be cause for rejection of the material. The following information is required on the Bill of Lading:

1. Date
2. Contract No. and/or Project Name
3. Grade of Commodity and Certification of Compliance
4. Anti-strip Type
5. Percent Anti-strip
6. Mass (Net Tonnes)
7. Volume (Gross Liters)
8. Temperature of Load (°C)
9. Bill of Lading Number
10. Consignee and Delivery Point
11. Signature of Supplier's Representative
12. Supplier (Bill of Lading Generator)
13. Supplier's Address
14. Refiner
15. Refiner's Location

The Bill of Lading shall be supplied at the time of shipment of each truck load, truck and trailer, or other lot of asphalt. In addition to the copies the Contractor requires, one copy of the Bill of Lading including the Certification Statement shall be sent with the shipment for agency use and one copy sent on a weekly basis to the Olympia Service Center Materials Laboratory, P.O. Box 167, Olympia, WA 98507-0167.

Cationic Emulsified Asphalt

Type	Rapid Setting				Medium Setting						Slow Setting				Special Tack	
WSDOT Test Method	CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2h		CSS-1		CSS-1h		STE-1	
Grade	Min.	Max	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on Emulsions:																
Viscosity Saybolt Furol S@ 25 °C	212	—	—	—	—	—	—	—	—	—	—	20	100	20	100	—	30
Viscosity Saybolt Furol S@ 50 °C	212	20	100	150	400	50	450	50	450	50	450	—	—	—	—	—	—
Storage stability test 1 day %	212	—	1	—	1	—	1	—	1	—	1	—	1	—	1	—	1
Demulsibility 35 ml 0.8% sodium dioctyl sulfosuccinate, %[a]	212	40	—	40	—	—	—	—	—	—	—	—	—	—	—	25	—
Coating ability & water resistance:																	
Coating, dry aggregate	212	—	—	—	—	Good	—	Good	—	Good	—	—	—	—	—	—	—
Coating, after spraying	212	—	—	—	—	Fair	—	Fair	—	Fair	—	—	—	—	—	—	—
Coating, wet aggregate	212	—	—	—	—	Fair	—	Fair	—	Fair	—	—	—	—	—	—	—
Coating, after spraying	212	—	—	—	—	Fair	—	Fair	—	Fair	—	—	—	—	—	—	—
Particle charge test	212	Pos		Pos		Pos		Pos		Pos		Pos[b]		Pos[b]		Pos	
Sieve Test, %	212	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10
Cement mixing test, %	212	—	—	—	—	—	—	—	—	—	—	—	2.0	—	2.0	—	—

Type	Rapid Setting				Medium Setting						Slow Setting				Special Tack	
WSDOT Test Method	CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2h		CSS-1		CSS-1h		STE-1	
Grade	Min.	Max	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Distillation:																
Oil distillate by vol. of emulsions %	212	—	3	1.5	3	—	20	—	12	—	12	—	—	—	—	—	5
Residue, %	212	60	—	65	—	60	—	65	—	65	—	57	—	57	—	45	—
Tests on residue from distillation tests:																
Penetration, 25 °C	201	100	250	100	250	100	250	100	250	40	90	100	250	40	90	100	200
Ductility, 25 °C 5 cm/min., cm	213	40	—	40	—	40	—	40	—	40	—	40	—	40	—	40	—
Solubility in trichloroethylene, %	214	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—

[a]The demulsibility test shall be made within 30 days from date of shipment.
[b]If the particle charge for test CSS-1 and CSS-1h is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

9-02.2(2) Samples

When requested by the Engineer, the asphalt supplier shall ship, by prepaid express or U.S. mail, samples of asphalt that represent current production.

9-02.3 Temperature of Asphalt

The temperature of paving asphalts in storage tanks when loaded for transporting to destination shall not be greater than 204°C.

9-02.4 Anti-Stripping Additive

When directed by the Engineer, heat-stable anti-stripping additive shall be added to the asphalt mix. At the option of the Contractor, the anti-stripping additive can be either added to the liquid asphalt or sprayed on the aggregate on the cold feed. Once the process and type of anti-stripping additive proposed by the Contractor have been approved by the Olympia Service Center Materials Laboratory, the process, brand, grade, and amount of anti-stripping additive shall not be changed without approval of the Engineer.

When liquid anti-stripping additive is added to the liquid asphalt, the amount will be designated by the Engineer, but shall not exceed 1 percent by mass of the liquid asphalt.

When polymer additives are sprayed on the aggregate, the amount will be designated by the Engineer, but shall not exceed 0.67 percent by mass of the aggregate.

The use of another process or procedure for adding anti-stripping additive to the asphalt mix will be considered based on a proposal from the Contractor.

9-03 AGGREGATES

9-03.1 Aggregates for Portland Cement Concrete

9-03.1(1) General Requirements

Portland cement concrete aggregates shall be manufactured from ledge rock, talus, or sand and gravel in accordance with the provisions of Section 3-01.

Aggregates found to be potentially reactive per AASHTO T 303 or ASTM C 1260 shall require mitigating measures. Expansions greater than 0.10 percent determined according to AASHTO T 303 or ASTM C 1260 will be considered to be potentially reactive. The Contracting Agency will conduct AASHTO T 303 in order to determine the potential reactivity of the aggregates, all other testing is the responsibility of the Contractor.

Mitigating measures may include the use of low alkali cement per 9-01.2(3), fly ash, or other material as approved by the Engineer. The Contractor shall submit evidence in the form of test results from ASTM C 1260 or AASHTO T 303 that demonstrate the proposed mitigation when used with cement and aggregates proposed will control the potential expansion before the aggregate source may be used in concrete. If fly ash is used, the Contractor shall provide test results from ASTM C 441 that show the fly ash does not cause an expansion reaction greater than that of the comparison control mixture prepared with cement of alkali between 0.40 and 0.60 percent.

Mitigating measures shall not be required if the Contractor provides test results from ASTM C 1293 that indicate the aggregate is not reactive. An expansion of less than 0.04 percent per ASTM C 1293 shall be considered evidence that the aggregates are not reactive.

9-03.1(2) Fine Aggregate for Portland Cement Concrete

Fine aggregate shall consist of sand or other inert materials, or combinations thereof, approved by the Engineer, having hard, strong, durable particles free from adherent coating. Fine aggregate shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious matter.

9-03.1(2)A Deleterious Substances

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

1. Particles of specific gravity less than 1.95 ..... 1.0 percent by mass.
2. Organic matter, by colorimetric test, shall not be darker than the reference standard color (organic plate No. 3) AASHTO T 21 unless other tests prove a darker color to be harmless.

9-03.1(2)B Grading

Fine aggregate shall be graded to conform to the following requirements expressed as percentages by mass:

Sieve Size	Class 1 Percent Passing	Class 2 Percent Passing
9.50 mm	100	100
4.75 mm	95-100	95-100
2.36 mm	68-86	---
1.18 mm	47-65	45-80
0.60 mm	27-42	---
0.30 mm	9-20	10-30
0.15 mm	0-7	2-10
0.075 mm	0-2.5	0-2.5

For fine aggregate Class 1, individual test variations under the minimum or over the maximum will be permitted as follows, provided the average of three consecutive tests is within the specification limits:

Number of Sieve	Permissible Percent of Variation in Individual Tests
0.60 mm and coarser	2
0.30 mm and finer	0.5

Within the gradation limits for fine aggregate Class 2, uniformity of gradation shall be limited to a range of plus or minus 0.20 of the reference fineness modulus. The reference fineness modulus shall be determined from a representative sample from the proposed source as submitted by the Contractor.

9-03.1(2)C Use of Substandard Gradings

Fine aggregate with more than the maximum percentage passing any sieve may be accepted provided the cement content of the finished concrete is increased at the Contractor's expense, $^1/_3$ percent for each 1 percent the fine aggregate passing each sieve is in excess of the maximum.

Under no circumstances shall fine aggregate Class 1 be used which has a grading finer than the following:

Sieve Size	Percent Passing
2.36 mm	95
1.18 mm	80
0.60 mm	60
0.30 mm	25
0.075 mm	2.5

All percentages are by mass.

9-03.1(3) Vacant

9-03.1(4) Coarse Aggregate for Portland Cement Concrete

Coarse aggregate for concrete shall consist of gravel, crushed stone, or other inert material or combinations thereof having hard, strong, durable pieces free from adherent coatings. Coarse aggregate shall be washed to remove clay, silt, bark, sticks, alkali, organic matter, or other deleterious material.

9-03.1(4)A Deleterious Substances

The amount of deleterious substances shall not exceed the following values:

Amount finer than 0.075 mm	1.00 percent by mass
Pieces of specific gravity less than 1.95	2.00 percent by mass
Clay lumps	0.50 percent by mass
Shale	2.00 percent by mass
Wood waste	0.05 percent by mass

For coarse aggregate with a minimum single face fracture content of 25 percent by mass, the material finer than the 0.075-millimeter sieve may increase to a maximum of 1.5 percent by mass. Fracture shall be determined in accordance with WSDOT Method 103 for each specification screen size 2.00 millimeter and above which retains more than 5 percent of the total sample.

9-03.1(4)B Wear in Los Angeles Machine

Coarse aggregate shall not have a percentage of wear in Los Angeles machine in excess of 35 after 500 revolutions.

9-03.1(4)C Grading

Coarse aggregate for Portland cement concrete when separated by means of laboratory sieves shall conform to one or more of the following gradings as called for elsewhere in these Specifications, Special Provisions, or in the Plans:

Passing Sieve Size	AASHTO Grading No. 467	AASHTO Grading No. 57	AASHTO Grading No. 67	AASHTO Grading No. 7	AASHTO Grading No. 8
50 mm	100	—	—	—	—
37.5 mm	95-100	100	—	—	—
25.0 mm	—	95-100	100	—	—
19.0 mm	35-70	—	90-100	100	—
12.5 mm	—	25-60	—	90-100	100
9.5 mm	10-30	—	20-55	40-70	85-100
4.75 mm	0-5	0-10	0-10	0-15	10-30
2.36 mm	—	0-5	0-5	0-5	0-10
1.18 mm	—	—	—	—	0-5

All percentages are by mass.

In individual tests, a variation of four under the minimum percentages or over the maximum percentages will be allowed. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no piece of greater size than two times the maximum sieve size for the specified grading measured along the line of greatest dimension.

When the Engineer approves, the coarse aggregate may be blended from other sizes if:

1. The resulting aggregate meets all requirements for the approved grading;
2. Each size used makes up at least 5 percent of the blend; and
3. The Contractor supplies the Engineer with gradings for the proposed sizes, along with their proper proportions.

9-03.2 Vacant

9-03.3 Vacant

9-03.4 Aggregate for Bituminous Surface Treatment

9-03.4(1) General Requirements

Aggregate for bituminous surface treatment shall be manufactured from ledge rock, talus, or gravel, in accordance with Section 3-01, which meets the following test requirements:

Los Angeles Wear, 500 Rev.	35% max.
Degradation Factor	30 min.

9-03.4(2) Grading and Quality

Aggregate for bituminous surface treatment shall conform to the requirements in the table below for grading and quality. The particular type or grading to be used shall be as shown in the Plans. All percentages are by mass.

The material shall meet the requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

	Crushed Cover Stone Percent Passing	Crushed Screening Percent Passing				
		19-12.5 mm	16-6.3 mm	12.5-6.3 mm	9.5-2.0 mm	6.3-0 mm
25.0 mm		100				
19.0 mm	100	95-100	100	---	---	---
16.0 mm	95-100	---	95-100	100	---	---
12.5 mm	---	0-20	---	95-100	100	---
9.5 mm	---	0-5	---	---	90-100	100
6.3 mm	30-50	---	0-10	0-15	50-75	90-100
2.00 mm	---	---	0-3	0-3	0-10	30-60
0.075 mm	0-7.5	0-1.0	0-1.0	0-1.0	0-1.0	0-10.0
% fracture, by mass, min.	75	75	75	75	75	75
Sand equivalent min.	32	---	---	---	---	---
Static Stripping Test	Pass	Pass	Pass	Pass	Pass	Pass

All percentages are by mass.

The fracture requirement shall be at least one fractured face and will apply to material retained on each specification sieve size 2.0 millimeter and above if that sieve retains more than 5 percent of the total sample.

The finished product shall be clean, uniform in quality, and free from wood, bark, roots, and other deleterious materials.

Crushed screenings shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves.

The portion of aggregate for bituminous surface treatment retained on a 6.3-millimeter sieve shall not contain more than 0.1 percent deleterious materials by mass.

9-03.5 Vacant

9-03.6 Aggregates for Asphalt Treated Base (ATB)

9-03.6(1) General Requirements

Aggregates for asphalt treated base shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01, that meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor	15 min.

9-03.6(2) Grading

Aggregates for asphalt treated base shall meet the following requirements for grading:

Sieve Size	Percent Passing
50 mm	100
12.5 mm	56-100
6.3 mm	40-78
2.00 mm	22-57
0.425 mm	8-32
0.075 mm	2.0-9.0
Asphalt Cement, Percent of Total Mixture	2.5-4.5

(Exact percentage of asphalt to be determined by the Engineer.)
All percentages are by mass.

9-03.6(3) Test Requirements

When the aggregates are combined within the limits set forth in Section 9-03.6(2) and mixed in the laboratory with the designated grade of asphalt, the mixture shall be capable of meeting the following test values:

Stabilometer Value	30 min.
Cohesiometer Value	50 min.
Modified Lottman Stripping Test	Pass

The sand equivalent value of the mineral aggregate for asphalt treated base shall not be less than 27.

9-03.7 Vacant

9-03.8 Aggregates for Asphalt Concrete

9-03.8(1) General Requirements

Aggregates for asphalt concrete shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01. The material from which they are produced shall meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	30 min.
Degradation Factor, Other Courses	20 min.

It shall be uniform in quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of any size between consecutive laboratory sieves.

Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that the oven-dried material retained on a 6.3-millimeter square sieve shall not contain more than 0.1 percent by mass of material with a specific gravity less than 1.0.

9-03.8(2) Test Requirements

Aggregate for asphalt concrete shall meet the following test requirements:

		Class of Asphalt Concrete					
		A	**B**	**D**	**E**	**F**	**G**
Fracture, by mass	(See Note)	1	2	3	4	4	2
Sand Equivalent	Min.	37	37	---	37	27	37

[1]The fracture requirements are at least one fractured face on 90 percent of the material retained on each specification sieve size 2.00 millimeter and above, if that sieve retains more than 5 percent of the total sample.

[2]The fracture requirements are at least one fractured face on 75 percent of the material retained on each specification sieve size 2.00 millimeter and above, if that sieve retains more than 5 percent of the total sample.

[3]The fracture requirements are at least two fractured faces on 75 percent and at least one fractured face on 90 percent of the material retained on each specification sieve, 2.36 millimeter and above, if that sieve retains more than 5 percent of the total sample.

[4]The fracture requirements are at least one fractured face on 50 percent of the material retained on each specification sieve size 2.00 millimeter and above, if that sieve retains more than 5 percent of the total sample.

When material is being produced and stockpiled for use on a specific contract or for a future contract, the fracture and sand equivalent requirements shall apply at the time of stockpiling. When material is used from a stockpile that has not been tested as provided above, the requirements for fracture and sand equivalents shall apply at the time of its introduction to the cold feed of the mixing plant.

The properties of the aggregate in a preliminary mix design for asphalt concrete shall be such that, when it is combined within the limits set forth in Section 9-03.8(6) and mixed in the laboratory with the designated grade of asphalt, mixtures with the following test values can be produced:

		Class of Asphalt Concrete					
		A	B	D	E	F	G
Stabilometer Value	Min.	37	35	---	35	35	35
Cohesiometer Value	Min.	100	100	---	100	50	100
Percent Air Voids		2-4.5	2-4.5	---	2-4.5	2-4.5	2-4.5
Modified Lottman Stripping Test		Pass	Pass	Pass	Pass	Pass	Pass

9-03.8(3) Grading

9-03.8(3)A Vacant

9-03.8(3)B Gradation

The Contractor may furnish aggregates for use on the same contract from a single stockpile or from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Section 9-03.8(6).

Acceptance of the aggregate gradation shall be based on samples taken from the final mix.

9-03.8(3)C Gradation — Recycled Asphalt Pavement and Mineral Aggregate

Asphalt concrete planings or old asphalt concrete utilized in the production of asphalt concrete shall be sized prior to entering the mixer so that a uniform and thoroughly mixed asphalt concrete is produced in the mixer. If there is evidence of the old asphalt concrete not breaking down during the heating and mixing of the asphalt concrete, the Engineer may elect to modify the maximum size entering the mixer. No contamination by deleterious materials will be allowed in the old asphalt concrete used.

The gradation for the new aggregate used in the production of the asphalt concrete shall be the responsibility of the Contractor, and when combined with recycled material, the combined material shall meet the gradation specification requirements for the specified Class ACP as listed in Section 9-03.8(6) and 9-03.8(6)A or as shown in the Special Provisions. The new aggregate shall meet the general requirements listed in Section 9-03.8(1) and shall meet the appropriate fracture and sand equivalent requirements as listed in Section 9-03.8(2).

9-03.8(4) Blending Sand

In the production of aggregate for asphalt concrete, there is often a deficiency of material passing the 0.425 millimeter. When this occurs, blending sand in an amount specified by the Engineer may be used to make up this deficiency, provided that a satisfactory final mix is produced, including fracture requirements.

Blending sand shall be clean, hard, sound material, either naturally occurring sand or crusher fines, and must be material which will readily accept an asphalt coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Section 9-03.8(6) for the class of material involved. Blending sand shall meet the following quality requirement:

Sand Equivalent	27 min.

9-03.8(5) Mineral Filler

Mineral filler, when used in ACP mix, shall conform to the requirements of AASHTO M 17.

9-03.8(6) Proportions of Materials

The materials of which asphalt concrete is composed shall be of such sizes, gradings, and quantities that, when proportioned and mixed together, they will produce a well graded mixture within the requirements listed in the table which follows.

The percentages of aggregate refers to completed dry mix, and includes mineral filler when used.

	Grading Requirements				
Sieve Size	Class A and B	Class D	Class E	Class F	Class G
	Percent Passing				
31.5 mm	---	---	100	---	---
25.0 mm	---	---	90-100	---	---
19.0 mm	100	---	---	100	---
16.0 mm	---	---	67-86	---	---
12.5 mm	90-100	100	60-80	80-100	100
9.5 mm	75-90	97-100	---	---	97-100
6.3 mm	55-75	---	40-62	45-78	60-88
4.75 mm	---	30-50	---	---	---
2.36 mm	---	5-15	---	---	---
2.00 mm	30-42	---	25-40	30-50	32-53
0.425 mm	11-24	---	10-23	---	11-24
0.075 mm	3.0-7.0	2.0-5.0	2.0-9.0	2.0-8.0	3.0-7.0

For asphalt concrete Class A, B, E, F, and G produced using recycled asphalt materials and placed in areas other than the wearing course of the traveled lane, the gradation for the 0.075-millimeter sieve is revised as follows:

	Maximum Passing 0.075 mm
50%-60% Recycled Material	8.0%
61%-70% Recycled Material	9.0%

9-03.8(6)A Basis of Acceptance

1. Asphalt Concrete will be accepted based on its conformance to the project job mix formula (JMF). For the determination of a project JMF, the Contractor shall submit to the Engineer, representative samples of the various aggregates, blend sand, and RAP to be used along with the gradation data showing the various aggregate stockpile averages and the proposed combining ratios and the average gradation of the completed mix. Based on this submittal, the Engineer will determine the asphalt content, anti-strip requirement, and asphalt retention factor in the mix design process. Using the representative samples submitted and proposed proportion of each, trial mix tests will be run to determine the percentage of asphalt, by mass, to be added. The JMF thus established shall be changed only upon order of the Engineer.

The intermingling of asphalt concrete mixtures produced from more than one JMF is prohibited. Each strip of asphalt concrete pavement placed during a working shift shall conform to a single job mix formula established for the class of asphalt concrete specified unless there is a need to make an adjustment in the JMF.

No mixture shall be produced for use on the project until the amount of asphalt material and anti-strip additive to be added has been established.

2. Job Mix Formula — Statistical Acceptance

The average gradation of the completed asphalt concrete mix submitted by the Contractor in the mix design proposal, as required in Section 9-03.8(6) and the resulting Mix Design Recommendations, shall be the JMF. Any change or adjustment of percentages in any constituent of the JMF creates a new JMF.

3. Job Mix Formula Tolerances and Adjustments

a. Tolerances — Statistical Acceptance. After the JMF is determined, the several constituents of the mixture at the time of acceptance shall conform to the following tolerances:

Constituent of Mixture	**Tolerance Limits**
	The tolerance limit for each mix constituent shall not exceed the broad band specification limits specified in Section 9-03.8(6), except the tolerance limits for sieves designated as 100% passing will be 99-100.
Aggregate passing 25.0 mm, 19.0 mm, 16.0 mm, 12.5 mm, and 9.5 mm sieves	Broad band specification limits Section 9-03.8(6)
Aggregate passing 6.3 mm sieve	± 6%
Aggregate passing 2.00 mm sieve	± 5%
Aggregate passing 0.425 mm sieve	± 4%
Aggregate passing 0.075 mm sieve	± 2.0% Note 1
Asphalt cement	± 0.5% Note 2

For open graded mix: Tolerance limits shall be for aggregate gradation only and shall be as specified in Section 9-03.8(6).

Note 1 — 2.0% if less than 50% RAP (Recycled Asphalt Pavement), 2.5% for 50% RAP or more.

Note 2 — 0.5% if less than 20% RAP, 0.7% for 20% and over RAP, but less than 50% RAP, 1.0% for 50% RAP or greater.

These tolerance limits constitute the allowable limits as described in Section 1-06.2.

b. Tolerances — Nonstatistical Acceptance. After the JMF is determined, the constituents of the mixture at the time of acceptance shall conform to the range of the proportion specified in the broad band specifications of Section 9-03.8(6) for gradation and the design mix asphalt content plus or minus 0.7 percent.

c. Adjustments

1. Aggregates. Upon written request from the Contractor, the Project Engineer may approve field adjustments to the JMF including the Contractor's proposed combining ratios for mineral aggregate stockpiles, blend sand, and RAP. The maximum allowed gradation change shall be 2 percent for the aggregate retained on the 2.00-millimeter sieve and above, 1 percent for the aggregate passing the 2.00-millimeter and 0.425-millimeter sieves, and 0.5 percent for the aggregate passing the 0.075-millimeter sieve. Blend sand may be changed a maximum of 5 percent. The above adjustments and/or any further adjustments as ordered by the Engineer will be considered as a new JMF. Adjustments beyond these limits will require development of a new JMF. The adjusted JMF plus or minus the allowed tolerances shall be within the range of the broad band specifications.
2. Asphalt Content. The Project Engineer may order or approve the Contractor's request to change asphalt content a maximum of 0.3 percent from the approved JMF. No field adjustments of the JMF relative to the asphalt cement content exceeding 0.3 percent from the initial JMF will be made without the approval of the Materials Engineer.

9-03.9 Aggregates for Ballast and Crushed Surfacing

9-03.9(1) Ballast

Ballast shall consist of crushed, partially crushed, or naturally occurring granular material from approved sources manufactured in accordance with the provisions of Section 3-01.

The material from which ballast is to be manufactured shall meet the following test requirements:

Los Angeles Wear, 500 Rev	40% max.
Degradation Factor	15 min.

Ballast shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Percent Passing
63 mm	100
50 mm	65-100
25.0 mm	50-85
6.3 mm	30-50
0.425 mm	16 max.
0.075 mm	9.0 max.
Dust Ratio: $\frac{\text{\% Pasing 0.075 mm}}{\text{\% Passing 0.425 mm}}$	$^2/_3$ max.
Sand Equivalent	27 min.

All percentages are by mass.

The portion of ballast retained on 6.3-millimeter sieve shall not contain more than 0.2 percent wood waste.

9-03.9(2) Shoulder Ballast

Shoulder ballast shall meet the requirements of Section 9-03.9(1) for ballast except for the following special requirements.

The grading and quality requirements are:

Sieve Size	Percent Passing
63 mm	100
19 mm	40-80
6.3 mm	5 max.
0.15 mm	0-2
% Fracture	75 min.

All percentages are by mass.

The sand equivalent value and dust ratio requirements do not apply.

The fracture requirement shall be at least one fractured face and will apply to material retained on each specification sieve size 6.3 millimeter and above if that sieve retains more than 5 percent of the total sample.

9-03.9(3) Crushed Surfacing

Crushed surfacing shall be manufactured from ledge rock, talus, or gravel in accordance with the provisions of Section 3-01. The materials shall be uniform in quality and substantially free from wood, roots, bark, and other extraneous material and shall meet the following test requirements:

Los Angeles Wear, 500 Rev.	35% max.
Degradation Factor — Top Course	25 min.
Degradation Factor — Base Course	15 min.

Crushed surfacing of the various classes shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Base Course	Top Course and Keystone
	Percent Passing	
31.5 mm	100	
19.0 mm		100
16.0 mm	50-80	
6.3 mm	30-50	55-75
0.425 mm	3-18	8-24
0.075 mm	7.5 max.	10.0 max.
% Fracture	75 min.	75 min.
Sand Equivalent	32 min.	32 min.

All percentages are by mass.

The fracture requirement shall be at least one fractured face and will apply to material retained on each specification sieve size 2.00 millimeter and above if that sieve retains more than 5 percent of the total sample.

The portion of crushed surfacing retained on a 6.3-millimeter sieve shall not contain more than 0.15 percent wood waste.

9-03.9(4) Maintenance Rock

Maintenance rock shall meet all requirements of Section 9-03.9(3) for crushed surfacing top course except that it shall meet the following specifications for grading:

Sieve Size	Percent Passing
12.5 mm	100
6.3 mm	55-70
0.425 mm	10-25
0.075 mm	7 max.

All percentages are by mass.

9-03.10 Aggregate for Gravel Base

Gravel base shall consist of granular material, either naturally occurring or processed. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily and shall meet the following test requirements:

Stabilometer "R" Value	72 min.
Swell pressure	2.07 kPa max.

The maximum particle size shall not exceed $^2/_3$ of the depth of the layer being placed.

Gravel base shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Percent Passing
6.3 mm	25 min.
0.075 mm	10.0 max.
Dust Ratio: $\frac{\text{\% Pasing 0.075 mm}}{\text{\% Passing 0.425 mm}}$	$^2/_3$ max.
Sand Equivalent	27 min.

All percentages are by mass.

Gravel base material retained on a 6.3-millimeter sieve shall contain not more than 0.20 percent by mass of wood waste.

9-03.11 Recycled Portland Cement Concrete Rubble

Recycled Portland cement concrete rubble may be used as, or blended with: ballast; shoulder ballast; crushed surfacing base and top course; maintenance rock; gravel backfill for foundation, walls, and pipe bedding; gravel borrow; bedding material for rigid pipe and flexible pipe; and foundation material Class A, B, and C.

A preliminary sample of the recycled concrete, and native material if any, used for ballast, shoulder ballast, crushed surfacing base and top course, maintenance rock, and gravel backfill for foundation Class A shall be submitted for testing for LA Wear and Degradation Factor. In addition, the source of any native material that may be blended with the recycled Portland cement concrete rubble shall also meet the specifications for LA Wear and Degradation Factor for the type aggregate being used.

A maximum of 20 percent by mass of recycled asphalt concrete pavement may be used in the blended product. The asphalt concrete content is calculated as the amount of asphalt particles retained on all screens 6.3 millimeter and above.

The recycled aggregates shall be stockpiled in such a manner that each certified test report will identify a single stockpile of not more than 10 000 tonnes.

The Contractor shall certify that the recycled material is neither hazardous or toxic. This certification shall address the toxicity characteristics prescribed in WAC 173-303-090(8) under sampling and testing according to WAC 173-303-110. Sampling and testing shall be one per 10 000 tonnes from any single source and not less than one sample from any single source.

Acceptance of the recycled concrete rubble aggregate for hazardous and toxic requirements shall be by Manufacturer's Certificate of Compliance with accompanying test reports.

Gradation, sand equivalent, and fracture requirements will be per the specific product outlined in these specifications.

9-03.12 Gravel Backfill

Gravel backfill shall consist of crushed, partially crushed, or naturally occurring granular material produced in accordance with the provisions of Section 3-01.

9-03.12(1) Gravel Backfill for Foundations

9-03.12(1)A Class A

Gravel backfill for foundations, Class A, shall conform to the requirements of Section 9-03.9 for ballast or 9-03.9(3) for crushed surfacing base course.

9-03.12(1)B Class B

Gravel backfill for foundations, Class B, shall conform to the requirements of Section 9-03.10 except that the requirements for stabilometer R value and swell pressure do not apply.

9-03.12(2) Gravel Backfill for Walls

Gravel backfill for walls shall consist of free draining granular material, essentially free from various types of wood waste or other extraneous or objectionable materials. It shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Percent Passing
100 mm	100
6.3 mm	25-70
0.075 mm	5.0 max.
Dust Ratio: $\frac{\text{\% Pasing 0.075 mm}}{\text{\% Passing 0.425 mm}}$	$^2/_3$ max.
Sand Equivalent	52 min.

All percentages are by mass.

That portion of the material retained on a 6.3-millimeter square opening shall contain not more than 0.20 percent by mass of wood waste.

9-03.12(3) Gravel Backfill for Pipe Zone Bedding

Gravel backfill for pipe zone bedding shall consist of crushed, processed, or naturally occurring granular material. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily and shall meet the following specifications for grading and quality:

Sieve Size	Percent Passing
25 mm	100
6.3 mm	25-80
0.075 mm	15.0 max.*
Sand Equivalent	27 min.

*5.0 max. for sanitary sewer installations.

All percentages are by mass.

9-03.12(4) Gravel Backfill for Drains

Gravel backfill for drains shall conform to the following gradings:

Sieve Size	Percent Passing
25.0 mm	100
19.0 mm	80-100
9.5 mm	10-40
4.75 mm	0-4
0.075 mm	0-2

Alkali silica reactivity testing is not required.

9-03.12(5) Gravel Backfill for Drywells

Gravel backfill for drywells shall conform to the following gradings:

Sieve Size	Percent Passing
37.5 mm	100
31.5 mm	90-100
19.0 mm	0-20
9.5 mm	0-2
0.075 mm	0-0.5

Alkali silica reactivity testing is not required.

9-03.13 Backfill for Sand Drains

Backfill for sand drains shall conform to the following grading:

Sieve Size	Percent Passing
12.5 mm	90-100
6.3 mm	65-100
2.00 mm	40-100
0.30 mm	3-30
0.15 mm	0-4
0.075 mm	0-3.0

All percentages are by mass.

9-03.13(1) Sand Drainage Blanket

Aggregate for the sand drainage blanket shall consist of granular material, free from wood, bark, or other extraneous material and shall meet the following requirements for grading:

Sieve Size	Percent Passing
63 mm	90-100
6.3 mm	30-100
The portion passing 6.3 mm shall meet the following requirements for grading:	
200 mm	50-100
0.30 mm	0-30
0.15 mm	0-7.0
0.075 mm	0-3.0

All percentages are by mass.

That portion of backfill for sand drains and sand drainage blanket retained on a 6.3-millimeter sieve shall contain not more than 0.05 percent by mass of wood waste.

9-03.14 Borrow

9-03.14(1) Gravel Borrow

Aggregate for gravel borrow shall consist of granular material, either naturally occurring or processed, and shall meet the following requirements for grading and quality:

Sieve Size	Percent Passing
100 mm[1]	100
4.75 mm	50-80
0.425 mm	30 max.
0.075 mm	7.0 max.
Sand Equivalent	42 min.

All percentages are by mass.

[1]For geosynthetic reinforced walls or slopes, the maximum particle size shall be limited to 31.5 mm.

9-03.14(2) Select Borrow

Material for select borrow shall consist of granular material, either naturally occurring or processed, and shall meet the following requirements for grading and quality:

Sieve Size	Percent Passing
150 mm[1,2]	100
0.425 mm	50 max.
0.075 mm	10.0 max.
Sand Equivalent	22 min.

All percentages are by mass.

[1]For geosynthetic reinforced slopes, the maximum particle shall be limited to 31.5 mm.

[2]The maximum particle size shall be limited to 100 mm when select borrow is used in the top 0.5 meter of embankments or where Method C compaction is required.

9-03.14(3) Common Borrow

Material for common borrow shall consist of granular or nongranular soil and/or aggregate which is free of deleterious material and is nonplastic.

Deleterious material includes wood, organic waste, coal, charcoal, or any other extraneous or objectionable material.

The material shall be considered nonplastic if the percent by mass passing the 0.075 mm sieve does not exceed 15 percent, or if the soil fraction passing the 0.425 mm sieve cannot be rolled, at any moisture content, into a thread as prescribed in Section 4 of AASHTO Standard Test Designation T 90. If requested by the Contractor, the plasticity may be increased with the approval of the Engineer if it is determined that an increased plasticity will be satisfactory for the specified embankment construction.

The material shall not contain more than 3 percent organic material by mass.

9-03.15 Bedding Material for Rigid Pipe

Bedding material for rigid pipe shall meet the requirements of Section 9-03.12(3) except the percent passing the 0.075-millimeter sieve shall be 7 percent maximum.

If, in the opinion of the Engineer, the native granular material is free from wood waste, organic material, and other extraneous or objectionable materials, it may be used for pipe bedding. The material shall have a maximum dimension of 38 millimeters.

9-03.16 Bedding Material for Thermoplastic Pipe

Bedding material for thermoplastic pipe shall be clean sand/gravel mixture free from organic matter and conforming to the following gradation:

Sieve Size	Percent Passing
19.0 mm	100
9.5 mm	70-100
4.75 mm	55-100
2.00 mm	35-95
0.85 mm	20-80
0.425 mm	10-55
0.15 mm	0-10
0.075 mm	0-3

All percentages are by mass.

9-03.17 Foundation Material Class A and Class B

Foundation material Class A and Class B shall conform to the following gradations:

	Percent Passing	
Sieve Size	Class A	Class B
63 mm	98-100	95-100
50 mm	92-100	75-100
37.5 mm	72-87	30-60
31.5 mm	58-75	0-15
19.0 mm	27-47	0-1
9.5 mm	3-14	---
4.75 mm	0-1	---

All percentages are by mass.

9-03.18 Foundation Material Class C

Foundation material Class C shall consist of clean bank run sand and gravel, free from dirt, roots, topsoil, and debris and contain not less than 35 percent retained on a 6.3-millimeter sieve and with all stones larger than 50 millimeters in the longest dimension removed.

9-03.19 Bank Run Gravel for Trench Backfill

Trench backfill material shall consist of aggregate for gravel base, as specified in Section 9-03.10, excepting however, that 100 percent of the material shall pass a 63-millimeter opening.

9-03.20 Test Methods for Aggregates

The properties enumerated in these Specifications shall be determined in accordance with the following methods of test:

Title	Test Method
Sampling	AASHTO T 2
Organic Impurities	AASHTO T 21
Clay Lumps in Aggregates	AASHTO T 112
Abrasion of Coarse Aggregates by Use of the Los Angeles Machine	AASHTO T 96
Material Finer than 0.075-millimeter Sieve in Aggregates	AASHTO T 11
Percent of Fracture in Aggregates	WSDOT No. 103
Sieve Analysis of Fine and Coarse Aggregates	AASHTO T 27
Sand Equivalent Test for Surfacing Materials	WSDOT FOP for AASHTO T 176
Determination of Degradation Value	WSDOT No. 113
Determination of Fineness Modulus	AASHTO T 27
Lightweight Pieces in Aggregates	WSDOT No. 122
Percentage of Particles Smaller than 0.075 mm and 0.005 mm	AASHTO T 88
Stabilometer R Value, Untreated Materials	WSDOT No. 611
Swell Pressure and Permeability	WSDOT No. 611
Stabilometer S Value, Treated Materials	WSDOT No. 703
Gradation of Aggregates in ACP	WSDOT No. 723
Determining Stripping of Asphalt Concrete	WSDOT No. 718
Compressive Strength of Concrete	AASHTO T 22
Flexural Strength of Concrete	WSDOT No. 802

9-03.21 Recycled Material

9-03.21(1) Reclaimed Glass (Mixed Waste Cullet) Additive to Aggregates

Reclaimed glass may be blended with the following:

Ballast	9-03.9(1)
Shoulder Ballast	9-03.9(2)
Crushed Surfacing Base Course	9-03.9(3)
Aggregate for Gravel Base	9-03.10
Gravel Backfill for Foundations, Class A	9-03.12(1)A
Gravel Backfill for Foundations, Class B	9-03.12(1)B
Gravel Backfill for Walls	9-03.12(2)
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)
Gravel Backfill for Drains	9-03.12(4)
Backfill for Sand Drains	9-03.13
Sand Drainage Blanket	9-03.13(1)
Borrow	9-03.14
Bedding Material for Rigid Pipe	9-03.15
Bedding Material for Thermoplatic Pipe	9-03.16
Foundation Material Class A and B	9-03.17
Foundation Material Class C	9-03.18
Bank Run Gravel for Trench Backfill	9-03.19

Aggregates containing reclaimed glass shall conform to the requirements of these Specifications for each item listed above. No aggregate shall contain more than 15 percent glass. No more than 10 percent of the material retained on an individual sieve 6.3 millimeters or larger shall be glass, based upon visual examination and mass.

9-03.21(2) Recycled Glass Aggregate

Aggregate composed solely of glass may be used as gravel backfill for walls, pipe bedding, and sand drains; sand drainage blanket; gravel borrow; and bedding material for flexible pipe.

One hundred percent of the glass shall pass a 19.0-millimeter square sieve and not more than 5 percent by mass shall pass a 0.075-millimeter sieve. Sieve analysis shall be conducted according to AASHTO T 27 on at least a quarterly basis by the product supplier. All test results shall be kept on file by the product supplier.

The maximum debris level shall be 10 percent. Debris is defined as any deleterious material which impacts the performance of the engineered fill and includes all non-glass constituents of the glass feed stock. The percentage of debris in cullet shall be quantified using the following visual method. Approximately 200 grams of processed cullet shall be placed in a flat pan or plate. The percentage of debris shall be estimated using AGI Data Sheets 15.1 and 15.2 "Comparison Charts for Estimating Percentage Composition," by the American Geological Institute, 1982.

Total lead content testing shall be performed quarterly by the product supplier. Tests shall include a minimum of 5 samples. Sample collection shall be conducted according to ASTM D 75. The mean of these tests shall not exceed 80 ppm. Total lead content testing will be conducted according to the EPA Method 3010/6010. All test results shall be kept on file by the product supplier.

9-04 JOINT AND CRACK SEALING MATERIALS

9-04.1 Premolded Joint Fillers

9-04.1(1) Asphalt Filler for Contraction and Longitudinal Joints in Concrete Pavements

Premolded joint filler for use in contraction and longitudinal joints shall be 3 millimeters in thickness and shall consist of a suitable asphalt mastic encased in asphalt-saturated paper or asphalt-saturated felt. It shall be sufficiently rigid for easy installation in summer months and not too brittle for handling in cool weather. It shall meet the following test requirements:

When a strip 50 millimeters wide and 600 millimeters long is freely supported 50 millimeters from each end and maintained at a temperature of 21°C, it shall support a mass of 100 grams placed at the center of the strip without deflecting downward from a horizontal position more than 50 millimeters within a period of 5 minutes.

9-04.1(2) Premolded Joint Filler for Expansion Joints

Premolded joint filler for use in expansion (through) joints shall conform to the specifications for "Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction," AASHTO M 213, except the requirement for water absorption which is deleted.

9-04.1(3) Vacant

9-04.1(4) Elastomeric Expansion Joint Seals

Premolded elastomeric expansion joint seals shall conform to the requirements of AASHTO M 220 and shall be formed by an extrusion process with uniform dimensions and smooth exterior surfaces. The cross-section of the seal shall be shaped to allow adequate compressed width of the seal, as approved by the Engineer.

9-04.2 Joint Sealants

9-04.2(1) Hot Poured Joint Sealants

Hot poured joint sealants shall meet the requirements of AASHTO M 173 Concrete Joint Sealer, Hot Poured Elastic Type and be sampled in accordance with ASTM D 5167. In addition, the sealant shall have a C.O.C. Flash Point (AASHTO T 48) of 205°C minimum. In lieu of the specified bond test in M 173, the bond test shall be in accordance with WSDOT Test Method 412.

9-04.2(2) Two Component Poured Rubber Joint Sealer

The physical properties of the joint sealer, when mixed in accordance with the manufacturer's recommendations, shall be as follows:

1. Color: Gray or black.
2.[1] Viscosity: Must be pourable and self-leveling at 10°C.
3.[1] Application Life: Not less than 3 hours at 22°C and 50 percent relative humidity.
4. Set to Touch: Not more than 24 hours at 22°C and 50 percent relative humidity.
5. Curing Time: Not more than 96 hours at 22°C and 50 percent relative humidity.
6. NonVolatile Content: Not less than 92 percent.
7. Hardness Rating (Durometer "Shore A"): 5-35.
8. Resiliency: Not less than 80 percent.

9. Bond test methods shall be in accordance with WSDOT Test Method No. 412.
[1]Viscosity and application life may be waived providing the material is mixed and placed by a pump and mixer approved by the Engineer.

Suitable primer, if required by the manufacturer, shall be furnished with each joint sealer. The primer shall be suitable for brush or spray application at 10°C or higher and shall cure sufficiently at 10°C to pour the joint within 24 hours. It shall be considered as an integral part of the sealer system. Any failure of the sealer in the test described herein, attributable to the primer, shall be grounds for rejection or re-testing of the sealer.

Acceptance of joint sealing compound for use on a project shall be on the basis of laboratory tests of samples representative of each batch of material to be used on the job. A period of at least two weeks shall be allowed for completion of tests. Each container of the compound shall be clearly identified as to batch number.

9-04.3 Joint Mortar

Mortar for hand mortared joints shall consist of one part Portland cement, three parts fine sand, and sufficient water to allow proper workability.

Cement shall conform to the requirements of AASHTO M 85, Type I or Type II.

Sand shall conform to the requirements of AASHTO M 45.

Water shall conform to the requirements of Section 9-25.1.

9-04.4 Pipe Joint Gaskets

9-04.4(1) Rubber Gaskets for Concrete Pipes and Precast Manholes

Rubber gaskets for use in joints of concrete culvert or storm sewer pipe and precast manhole sections shall conform to the applicable requirements of AASHTO M 198.

9-04.4(2) Vacant

9-04.4(3) Gaskets for Aluminum or Steel Culvert or Storm Sewer Pipe

Rubber gaskets for use with metal culvert or storm sewer pipe shall be continuous closed cell, synthetic expanded rubber gaskets conforming to the requirements of ASTM D 1056, Grade 2B3. Butyl rubber gaskets for use with metal culvert or storm sewer pipe shall conform to the applicable requirements of AASHTO M 198.

9-04.4(4) Rubber Gaskets for Aluminum or Steel Drain Pipe

Gaskets for metal drain pipe shall be self-adhering, butyl-based, scrim-supported type. The gaskets shall be as described in the Standard Plan when specified.

9-04.4(5) Protection and Storage

Rubber gasket material shall be stored in a clean, cool place, protected from sunlight and contaminants. They shall be protected from direct sunlight at all times except during actual installation. Pipes with gaskets affixed shall be installed in the line within 28 days.

9-04.5 Flexible Plastic Gaskets

The gasket material shall be produced from blends of refined hydro-carbon resins and plasticizing materials reinforced with inert mineral filler and shall contain no solvents. It shall not depend on oxidizing, evaporating, or chemical action for adhesive or cohesive strength. It shall be supplied in extruded rope-form of such cross-section and size as to adequately fill spaces between the precast sections.

The gasket material shall be protected by a suitable removable two-piece wrapper so designed as to permit removing one half, longitudinally, without disturbing the other. Its composition and properties shall conform to those set forth below.

	Test Method	Minimum	Maximum
Bitumen (Petroleum plastic content)	ASTM D 4	50	70
Ash-inert Mineral Matter	AASHTO T 111	30	50
Penetration	ASTM D 217		
0°C (300gm) 60 sec		75	---
25°C (150gm) 5 sec		50	120
46°C (150gm) 5 sec		---	150
Softening Point	ASTM D 36	160°C	---
Specific Gravity at 25°C	ASTM D 71	1.20	1.35
Mass per liter, kg		1.25	1.35
Ductility at 25°C (cm)	ASTM D 113	5.0	---
Flash Point COC, °C	ASTM D 93	316	---
Fire Point COC, °C	ASTM D 92	329	---
Volatile Matter	ASTM D 6	---	2.0

9-04.6 Expanded Polystyrene

Expanded polystyrene shall be of a cellular molded type with a density of 24 kilograms per cubic meter plus or minus 4.0 kilograms per cubic meter.

9-04.7 Expanded Rubber

Closed cell expanded rubber joint filler shall conform to ASTM D 1056, Grade No. 2B3.

9-04.8 Flexible Elastomeric Seals

Flexible elastomeric seals for PVC drain pipe and underdrain pipe shall conform to the requirements of ASTM D 3212.

9-04.9 Solvent Cements

Solvent cements for PVC underdrain pipe shall conform to the requirements of ASTM D 2564.

9-04.10 Crack Sealing — Rubberized Asphalt

Crack sealing material shall meet the requirements of Section 9-04.2(1), except no bond text is required.

9-04.11 Butyl Rubber

Butyl rubber shall conform to ASTM D 2000, M1 BG 610.

9-05 DRAINAGE STRUCTURES, CULVERTS, AND CONDUITS

9-05.0 Acceptance by Manufacturer's Certification

Certain drainage materials may be accepted by the Engineer based on a modified acceptance procedures when materials are furnished from the manufacturer's list in the Qualified Products List (QPL) or by a Manufacturer's Certificate of Compliance. The modified acceptance procedure is defined in the QPL for each material. These materials are as follows:

Metal drain and under drain pipe;
PVC and corrugated polyethylene drain pipe and under drain pipe;
Metal culvert and storm sewer pipe and pipe arch;
Metal culvert end sections;
Corrugated metal structural plate pipe, pipe arch, and under passes; and
Ductile iron pipe.
Corrugated polyethylene culvert and storm sewer pipe up to and including 900-millimeter diameter.
Profile wall PVC culvert and storm sewer pipe up to and including 900-millimeter diameter.

9-05.1 Drain Pipe

9-05.1(1) Concrete Drain Pipe

Concrete drain pipe shall meet the requirements of ASTM C 118M, heavy duty drainage pipe.

9-05.1(2) Zinc Coated (Galvanized) or Aluminum Coated (Aluminized) Corrugated Iron or Steel Drain Pipe

Zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of AASHTO M 36M. The galvanized or aluminized sheet thickness shall be 1.3 millimeters for 150-millimeter diameter drain pipe and 1.6 millimeters for 200-millimeter diameter and larger drain pipe. Welded seam aluminum coated (aluminized) corrugated iron or steel drain pipe with metallized coating applied inside and out following welding is acceptable.

9-05.1(2)A Coupling Bands

Coupling bands for zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 36M, except that bands using projections (dimples) shall not be permitted. The bands shall be fabricated of the same material as the pipe, and with the same metallic protective treatment as the pipe.

Acceptable coupling bands are the two-piece helically corrugated band with nonreformed ends and integrally formed flanges and those bands meeting the requirements of Section 9-05.4(7).

9-05.1(3) Corrugated Aluminum Alloy Drain Pipe

Corrugated aluminum alloy drain pipe shall meet the requirements of AASHTO M 196M, without perforations.

9-05.1(3)A Coupling Bands

Coupling bands for corrugated aluminum alloy drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 196M, except that bands using projections (dimples) shall not be permitted. The bands shall be fabricated of the same material as the pipe.

Acceptable coupling bands are the two-piece helically corrugated band with nonreformed ends and integrally formed flanges and those bands meeting the requirements of Section 9-05.5(5).

9-05.1(4) Vacant

9-05.1(5) PVC Drain Pipe

PVC drain pipe shall meet the requirements of AASHTO M 278. The maximum size pipe shall be 200 millimeters in diameter.

9-05.1(6) Corrugated Polyethylene Drainage Tubing Drain Pipe

Corrugated polyethylene drainage tubing drain pipe shall meet the requirements of AASHTO M 252. The maximum size pipe shall be 250 millimeters in diameter.

9-05.1(7) Corrugated Polyethylene Drain Pipe

Corrugated polyethylene drain pipe, 300-millimeter through 900-millimeter diameter maximum, shall meet the minimum requirements of AASHTO M 294 Type S.

9-05.2 Underdrain Pipe

9-05.2(1) Vacant

9-05.2(2) Perforated Concrete Underdrain Pipe

Perforated concrete underdrain pipe shall meet the requirements of AASHTO M 175M, Type I, except the perforations shall be approximately 13 millimeters in diameter. Strength requirements shall be as shown in Table I of AASHTO M 86M.

9-05.2(3) Perforated Bituminized Fiber Underdrain Pipe

Perforated bituminized fiber underdrain pipe shall meet the requirements of AASHTO M 177.

9-05.2(4) Zinc Coated (Galvanized) or Aluminum Coated (Aluminized) Corrugated Iron or Steel Underdrain Pipe

Zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel underdrain pipe shall meet the requirements of AASHTO M 36M, except that perforations required in Class I, II, and III pipe may be located anywhere on the tangent of the corrugations provided the other perforation spacing requirements remain as specified. Welded seam aluminum coated (aluminized) corrugated iron or steel underdrain pipe with metallized coating applied inside and out following welding is acceptable.

The pipe may conform to any one of the Type III pipes specified in AASHTO M 36M, and perforations in Class I, II, and III pipe may be drilled or punched. The galvanized or aluminized sheet thickness shall be 1.3 millimeters for 150-millimeter diameter underdrain pipe and 1.6 millimeters for 200-millimeter and larger diameter underdrain pipe.

9-05.2(4)A Coupling Bands

Coupling bands for zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel underdrain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 36M. The bands shall be fabricated of the same material as the pipe and with the same metallic protective treatment as the pipe, if metallic bands are used.

Acceptable coupling bands are the two-piece helically corrugated band with nonreformed ends and integrally formed flanges, universal bands (dimple bands), a smooth sleeve type coupler, and those bands meeting the requirements of Section 9-05.4(7). Smooth sleeve type couplers may be either plastic or steel suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.2(5) Perforated Corrugated Aluminum Alloy Underdrain Pipe

Perforated corrugated aluminum alloy underdrain pipe shall meet the requirements of AASHTO M 196M, except that the perforations may be located anywhere on the tangent of the corrugations providing the other perforation spacing requirements remain as specified.

9-05.2(5)A Coupling Bands

Coupling bands for corrugated aluminum alloy underdrain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 196M. The bands shall be fabricated of the same material of the pipe, if metallic bands are used.

Acceptable coupling bands are the two-piece helically corrugated band with nonreformed ends and integrally formed flanges, universal bands (dimple bands), a smooth sleeve type coupler, and those bands meeting the requirements of Section 9-05.5(5). Smooth sleeve type couplers may be either plastic or aluminum alloy suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.2(6) Perforated PVC Underdrain Pipe

Perforated PVC underdrain pipe shall meet the requirements of AASHTO M 278. The maximum size pipe shall be 200 millimeters in diameter.

9-05.2(7) Perforated Corrugated Polyethylene Drainage Tubing Underdrain Pipe

Perforated corrugated polyethylene drainage tubing underdrain pipe shall meet the requirements of AASHTO M 252. The maximum size pipe shall be 250 millimeters in diameter.

9-05.2(8) Perforated Corrugated Polyethylene Underdrain Pipe

Perforated corrugated polyethylene underdrain pipe, 300-millimeter through 900-millimeter diameter maximum, shall meet the minimum requirements of AASHTO M 294 Type S. Perforations shall be in accordance with AASHTO M 252.

9-05.3 Concrete Culvert Pipe

9-05.3(1) Plain Concrete Culvert Pipe

Plain concrete culvert pipe shall be round and shall conform to the requirements of AASHTO M 86M, Class 2.

9-05.3(1)A End Design and Joints

All bell and spigot concrete culvert pipe shall be joined with rubber gaskets. The joints and gasket material shall meet the requirements of AASHTO M 198. Gasket material shall be handled and stored in accordance with Section 9-04.4(5).

The plans of the ends of the pipes shall be perpendicular to their longitudinal axes.

9-05.3(1)B Basis for Acceptance

The basis for acceptance of plain concrete culvert or drain pipe shall be on the results of three edge bearing tests performed at the manufacturer's plant within the 90-day period immediately preceding shipment of the pipe.

9-05.3(1)C Age at Shipment

Plain concrete culvert pipe may be shipped when it meets all test requirements. Unless it is tested and accepted at an earlier age, it shall not be considered ready for shipment sooner than 28 days after manufacture when made with Type II Portland cement, nor sooner than 7 days when made with Type III Portland cement.

9-05.3(2) Reinforced Concrete Culvert Pipe

Reinforced concrete culvert pipe shall be round and conform to the requirements of AASHTO M 170M except as herein provided.

The wall thickness and steel area for all classes of pipe which are of a diameter not set forth in AASHTO M 170M, but within the maximum and minimum diameter limits set forth therein, shall be determined by interpolation from data given in the tables for pipes of diameters next smaller and next larger, respectively.

For all classes of pipe, except Class I, which are of a diameter less than the minimum for the particular class set forth in AASHTO M 170M, the minimum wall thickness shall be 45 millimeters and the steel area shall not be less than 0.127 square millimeters per millimeter of pipe barrel length.

9-05.3(2)A End Design and Joints

Section 9-05.3(1)A will apply to reinforced concrete culvert pipe.

9-05.3(2)B Basis for Acceptance

The basis for acceptance of reinforced concrete pipe 1500 millimeters in diameter and smaller shall be determined by the results of the three edge bearing test for the load to produce a 0.25-millimeter crack, and testing to the ultimate load will ordinarily not be required, except as necessary to obtain samples for making the absorption test. In lieu of broken pieces of pipe obtained as above provided, 100-millimeter diameter cores from pipe sections selected by the Engineer may be furnished for performing the absorption test. Sections of pipe which have been tested to the actual 0.25-millimeter crack will ordinarily not be further load tested; and such sections which meet or exceed the required strength and workmanship standards may be accepted for use on the project.

Acceptance of reinforced concrete pipe larger than 1500 millimeters in diameter shall be based on inspection of the size and placement of the reinforcing steel, and, at the option of the Engineer, on compressive strength tests of 100-millimeter diameter cores cut from the pipe, or on compressive strength of representative test cylinders cast with and cured with the pipe.

9-05.3(2)C Age at Shipment

Reinforced concrete culvert pipe may be shipped when it meets the requirements of Section 9-05.3(1)C.

9-05.3(2)D Elliptical Reinforcement

In lieu of marking circular pipe with elliptical reinforcement in accordance with AASHTO M 170M, the location of the top of the pipe shall be indicated by 75-millimeter, waterproof, painted stripes on the inside and outside of the pipe for a distance of

600 millimeters from each end of the section. At the option of the Contractor, a lift hole or lift holes may be provided at the top of the pipe in lieu of the painted stripes. If one lift hole is provided, it shall be at the balance point of the pipe; and if two lift holes are provided, they shall be spaced equidistant each side of the balance point. Such holes shall not interfere with the reinforcement. After placing, open lift holes shall be filled with mortar or concrete plugs before backfilling.

In addition to the requirements as set forth in AASHTO M 170M, it will be required on all pipe 750 millimeters and over in diameter with elliptical steel reinforcement that the manufacturer expose the reinforcement in not less than one of three lengths of pipe manufactured. A hole exposing the steel shall be cut on the inside of the pipe at top or bottom and a second hole on the outside, 90 degrees from the top or bottom position. After placing, holes exposing the reinforcement shall be filled with mortar or concrete plugs before backfilling.

9-05.3(3) Beveled Concrete End Sections

Beveled concrete end sections shall be plain concrete conforming to AASHTO M 86M or reinforced concrete conforming to the applicable sections of AASHTO M 170M with the design requirements as listed in Table 2, Wall B, Circular Reinforcement in circular pipe, and the Standard Plan.

9-05.4 Steel Culvert Pipe and Pipe Arch

Steel culvert pipe and pipe arch shall meet the requirements of AASHTO M 36M, Type I and Type II. Welded seam aluminum coated (aluminized) corrugated steel pipe and pipe arch with metallized coating applied inside and out following welding is acceptable.

9-05.4(1) Elliptical Fabrication

When elongated pipes are specified, circular pipes shall be fabricated 5 percent out of round to form an elliptical section. The vertical or longer axis of the elliptical section shall be clearly marked before shipping.

9-05.4(2) Mitered Ends

The ends of steel culvert pipe or pipe arch shall not be beveled unless called for in the plans. If beveled ends are specified, the ends of culvert pipe over 750 millimeters in diameter shall be mitered to conform to the slope of the embankment in which the culvert is to be placed whether the culvert is constructed normal to or at an angle with the centerline of the roadway.

Beveled steel pipe end sections 300 millimeters through 750 millimeters in diameter shall be of the same material and thickness and have the same protective coating as the pipe to which they are attached. Beveled pipe ends of these dimensions shall be constructed in conformance with the Standard Plan.

9-05.4(3) Protective Treatment

Steel pipe and pipe arch culverts shall be coated by one of the following protective treatments, when such treatment is specified:

Treatment 1 — Coated uniformly inside and out with asphalt.
Treatment 2 — Coated uniformly inside and out with asphalt and with an asphalt paved invert.
Treatment 3 — Coated inside and out with fibers embedded in the spelter coating and then covered on both sides with asphalt.

Treatment 4 — Coated as in Treatment 3 and with an asphalt paved invert.
Treatment 5 — Coated inside and out with asphalt and a 100 percent periphery inside spun asphalt lining.
Treatment 6 — Coated as in Treatment 3 and with a 100 percent periphery inside spun asphalt lining.

9-05.4(4) Asphalt Coatings and Paved Inverts

Asphalt for asphalt coatings and paved inverts shall meet the requirements of AASHTO M 190, Section 4. The coatings for Treatments 1, 2, and 5 shall be uniform, inside and out, and applied in accordance with the following requirements:

The metal shall be free from grease, dirt, dust, moisture, or other deleterious contaminants. Either process described below may be used for application.

1. Pipe Not Preheated. The temperature of the asphalt at the time of pipe immersion shall be 200°C (plus or minus 3 degrees), and the duration of the immersion shall conform to the following schedule:

Thickness in Millimeters		Minimum Immersion
Steel	**Aluminum**	**Time-Minutes**
1.6	1.5	2.5
2.0	1.9	3.0
2.8	2.7	5.0
3.5	3.4	6.5
4.3	4.2	8.0

2. Pipe Preheated. The asphalt shall have a temperature of 190°C (plus or minus 3 degrees), and the pipe shall be brought to a temperature of 150°C to 175°C before immersion.

   Paved inverts for Treatments 2 and 4 shall consist of bituminous material applied in such a manner that one or more smooth pavements will be formed in the invert filling the corrugations for at least 40 percent of the circumference. The pavement shall have a minimum thickness of 3 millimeters above the crest of the corrugations except where the upper edges intercept the corrugation. The pavements shall be applied following the coating with asphalt or fiber bonding.

   Treatment 5 may be substituted for Treatment 2, and Treatment 6 for Treatment 4 at the option of the Contractor.

9-05.4(5) Vacant

9-05.4(6) Spun Asphalt Lining

Asphalt for spun linings over 100 percent periphery shall conform to AASHTO M 190, Section 4. Asphalt spun linings shall provide a smooth surface for the full interior of the pipe by completely filling the corrugations to a minimum thickness of 3 millimeters above the crests. The interior lining shall be applied by centrifugal or other approved methods. The interior shall be free from sags or runs, but slight residual corrugations due to cooling shrinkage of the lining will not be cause for rejection. At the three-sheet laps, an interior nonuniformity equal to the thickness of the sheet is allowable. The thickness of the lining shall be maintained to the ends of the pipe.

The thickness of the lining over the crest of the corrugation shall not vary by an amount in excess of 13 millimeters over the entire area of the spun lining.

In the case of helical corrugated pipe manufactured with a continuous lock seam, an interior nonuniformity over the lock seam equal to the thickness of two culvert sheets is allowable.

9-05.4(7) Coupling Bands

Coupling bands for steel pipe shall be as shown in the Standard Plans and shall be fabricated of the same material as the pipe. Bands may be up to three nominal thicknesses thinner than used for the pipe, but not thinner than 1.6 millimeters or thicker than 2.8 millimeters. Bands shall be coated with the same metallic protective treatment as the pipe but shall not be coated with any asphalt protective treatment. Bands shall be made by the same manufacturer as the steel pipe selected for installation.

Corrugations on the bands shall be the same size and shape as those on the pipes to be connected. Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with AASHTO M 232. Steel angles, when required for coupling bands, shall meet the requirements of AASHTO M 36. When annular corrugated bands are used to connect helically corrugated lock-seam pipe, the seam shall be welded at the pipe ends prior to recorrugating to prevent unraveling of the seam. All welds shall develop the full strength of the parent metal.

Bands shall conform to the corrugations of the pipe and shall meet all applicable requirements of AASHTO M 36, with the following exceptions:

Coupling bands for all sizes of steel pipe arch with 75-millimeter by 25 millimeter corrugations shall be 600 millimeters wide.

Type K coupling bands shall only be used on circular culvert pipe when extending an existing culvert. Rubber gaskets shall be used and shall conform to the requirements of Section 9-04.4(3), match the width of the band, and have a minimum thickness of 25 millimeters.

Type K coupling bands are allowed for use on all sizes of steel pipe arch with 75-millimeter by 25-millimeter corrugations. Type K bands for this application shall be 600 millimeters wide. Rubber gaskets shall be used and shall conform to the requirements of Section 9-04.4(3), match the width of the band, and have a minimum thickness of 25 millimeters. When Type K bands are used, pipe arch ends are not required to be recorrugated.

Gaskets are required for all culvert installations and shall meet the requirements of 9-05.10(1).

9-05.4(8) Steel Nestable Pipe

Steel nestable pipe shall meet the requirements for steel pipe of these Specifications except in the method of fabrication. Circular pipe shall be fabricated in two semi-circles.

Nestable pipe may be either the stitch-type as hereinafter described or the flange-type in accordance with Military Designation MIL-P-236. One longitudinal edge of each half of the stitch-type nestable circular pipe shall be notched to provide interlocking seams which will form the two segments into the full section when it is erected in the field. Hook and eye bolts, or other approved means, shall be provided to hold the segments firmly together.

Individual plates shall be a minimum of 600 millimeters in length except for short or half sections required to complete the end section of the culvert.

When protective treatment is specified in the Plans, nestable pipe shall be coated with one of the treatments as provided in Section 9-05.4(3).

9-05.4(9) Steel End Sections

The applicable provisions of AASHTO M 36M shall apply to the construction of steel end sections, except that the end sections shall be fabricated of the same material with the same metallic protective treatment as the pipe.

Asphalt coating shall not be used on steel end sections.

9-05.4(9)A Fabrication

The shape, thickness, dimensions, and number of pieces shall conform to the Standard Plan for the size and shape of pipe shown in the Plans. They shall be manufactured as integral units or so formed that they can be readily assembled and erected in place. When bolts are used for assembly, they shall be 10-millimeter diameter or larger and shall be galvanized. No field welding or riveting will be permitted.

9-05.4(9)B Galvanized Hardware

Bolts, nuts, and miscellaneous hardware shall be galvanized in accordance with the provisions of AASHTO M 232.

9-05.4(9)C Toe Plate Extensions

Toe plate extensions shall be furnished only when so designated in the Plans. When required, the toe plate extensions shall be punched with holes to match those in the lip of the skirt and fastened with 10-millimeter or larger galvanized nuts and bolts. Toe plate extensions shall be the same material and thickness as the end section and shall be fabricated of the same material with the same metallic protective treatment as the end section.

9-05.5 Aluminum Culvert Pipe

Aluminum culvert pipe shall conform to the applicable requirements of AASHTO M 196M.

9-05.5(1) Elliptical Fabrication

Section 9-05.4(1) shall apply to aluminum pipes.

9-05.5(2) Mitered Ends

Section 9-05.4(2) shall apply to aluminum pipes.

9-05.5(3) Protective Treatment

When protective treatment is specified for aluminum pipe, it shall be Treatment 5 as shown in Section 9-05.4(3).

9-05.5(4) Asphalt Coatings

Asphalt coatings for aluminum culvert pipe shall meet the requirements of Section 9-05.4(4).

9-05.5(5) Coupling Bands

Bands shall be fabricated of the same material as the pipe and shall meet all applicable requirements of AASHTO M 196, except the band thickness shall not be more than 2.7 millimeters or less than 1.5 millimeters. All other requirements of Section 9-05.4(7) shall apply.

9-05.5(6) Aluminum End Sections

The applicable provisions of AASHTO M 196M shall apply to the construction of end sections and toe plate extensions for aluminum pipes. In addition, they shall conform to the requirements of Section 9-05.4(9).

Asphalt coating shall not be used on aluminum end sections.

9-05.6 Structural Plate Pipe, Pipe Arch, Arch, and Underpass

9-05.6(1) General

Structural plate pipes shall be full circle of the type, gage or thickness, and diameter specified.

Structural plate pipe arches shall be a multi-centered shape, made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis, and of the type, gage or thickness, and span specified.

Structural plate arches shall be a single-centered circular arc shape placed on a reinforced concrete foundation, and of the design, type, gage or thickness, and span as provided for in the Plans.

Structural plate underpasses shall be a multi-centered shape, made up of a variable number of circular arcs tangent to each other at their junctions and symmetrical about the vertical axis, and of the design, type, gage or thickness, and span specified.

9-05.6(2) Fabrication

The plates at longitudinal and circumferential seams shall be connected by bolts; the bolt holes shall be staggered in rows 50 millimeters apart, one hole being punched in the valley and one in the crest of each corrugation along both edges of each plate. Bolt holes on circumferential seams shall be spaced at approximate 300-millimeter intervals. No hole shall be closer to the edge of the plate than twice the diameter of the bolt.

The ends of structural plate pipes, pipe arches, arches, or underpasses shall not be mitered unless called for in the Plans, Special Provisions, or Standard Plan. If mitered ends are specified, the slope shall conform to the slope of the embankment in which the culvert is to be placed. The miter on pipe arches shall be limited to the top arc only.

9-05.6(3) Elliptical Fabrication

When elongated structural plate pipes are specified, they shall be fabricated 5 percent out of round to form an elliptical cross-section. The vertical axis (the longer axis of the elliptical section) shall be clearly marked on the plates before shipping.

9-05.6(4) Structural Plate Pipe Arch

Plates for structural plate pipe arches shall be formed so that the top shall be an arc of not more than 180 degrees nor less than 155 degrees; the bottom shall be an arc of not more than 50 degrees nor less than 10 degrees; and the top shall be joined at each end to the bottom by an arc having a radius between 450 and 775 millimeters and of not more than $87^{1}/_{2}$ degrees nor less than 75 degrees.

9-05.6(5) Structural Plate Arch

Structural plate arches and their foundations shall be as shown in the Plans.

9-05.6(6) Structural Plate Underpass

Structural plate underpasses shall be as provided for in the Standard Plans, or, in the case of a special design, as provided for in the Plans.

9-05.6(7) Concrete

Concrete required for constructing structural plate arch foundations shall be Class 20 concrete in conformance with the requirements of Section 6-02.

Steel reinforcing bars shall conform to the requirements of Section 9-07.1.

9-05.6(8) Plates

9-05.6(8)A Corrugated Steel Plates

Galvanized corrugated steel plates for constructing structural plate pipe, pipe arches, arches, and underpasses, and nuts and bolts used in their assembly shall conform to the requirements of AASHTO M 167M except that the minimum mass of spelter coating on the plates shall be 910 grams of zinc per square meter of double exposed surface. If the average spelter coating as determined from the required samples is less than 910 grams, or if any one specimen shows less than 820 grams, the lot samples shall be rejected. Nuts, bolts, and miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

9-05.6(8)B Corrugated Aluminum Plates

Aluminum alloy plates and fasteners intended for use in the construction of structural plate pipe, pipe arches, arches, and underpasses shall conform to the requirements of AASHTO M 219M. Nuts, bolts, and miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

9-05.7 Concrete Storm Sewer Pipe

9-05.7(1) Plain Concrete Storm Sewer Pipe

Plain concrete storm sewer pipe shall conform to the requirements of AASHTO M 86M, Class 2.

9-05.7(1)A Basis for Acceptance

The basis for acceptance of plain concrete storm sewer pipe shall be the same as specified in Section 9-05.3(1)B.

9-05.7(2) Reinforced Concrete Storm Sewer Pipe

Reinforced concrete storm sewer pipe shall conform to the requirements of AASHTO M 170M and shall be of the class noted in the Plans or in the Special Provisions. Section 7.3.1 of AASHTO M 170M shall be amended to require that both bells and spigots shall be reinforced in pipe 750 millimeters in diameter and greater.

The identification of the minor axis of elliptical reinforcement shall be in accordance with Section 9-05.3(2)D.

9-05.7(2)A Basis for Acceptance

The basis for acceptance of reinforced concrete storm sewer pipe shall be the same as specified in Section 9-05.3(2)B.

9-05.7(3) Concrete Storm Sewer Pipe Joints

All concrete storm sewer pipe shall be joined with rubber gaskets. The joints and gasket material shall meet the requirements of AASHTO M 198. Gasket material shall be handled and stored in accordance with Section 9-04.4(5).

9-05.7(4) Testing Concrete Storm Sewer Pipe Joints

When a particular type of pipe joint design, material or joining method has not previously been tested and approved, the following test shall be made on one test length of the assembled storm sewer pipe to qualify the design, material or method of joining the pipe. At the option of the Engineer, additional testing may be requested if subsequent field testing of installed pipe indicates difficulty in obtaining properly joined pipe. The tests will be conducted at the manufacturer's yard, and the manufacturer will be required to make such space and facilities available as required to conduct the tests in an efficient and workmanlike manner.

9-05.7(4)A Hydrostatic Pressure on Pipes in Straight Alignment

Hydrostatic pressure tests on pipes in straight alignment shall be made in accordance with the procedure outlined in paragraph 8(a) of AASHTO M 198, except that they shall be performed on an assembly consisting of not less than three nor more than five pipe sections selected from stock by the Engineer and assembled in accordance with standard installation instructions issued by the manufacturer. The end sections shall be bulkheaded and restrained against internal pressure.

9-05.7(4)B Hydrostatic Pressure Tests on Pipes in Maximum Deflected Position

Upon completion of the test for pipe in straight alignment, the test section shall be deflected until at least two of the joints have been deflected to the maximum amount shown in the manufacturer's standard installation instructions. When thus deflected, there shall be no leakage at the joints from an applied internal hydrostatic pressure of 35 kilopascals.

9-05.7(4)C Hydrostatic Pressure Test on 375-Millimeter Diameter and Larger Pipe Under Differential Load

The test sections shall be suitably supported so that one of the pipes of the test assembly is suspended freely between adjacent pipes, bearing only on the joints. The suspended pipe shall then be loaded, at its midpoint, in addition to the mass of the pipe, in accordance with the following schedule:

Diameter	Load
375 millimeters	33 kilonewtons
450 millimeters	39 kilonewtons
525 millimeters	44.5 kilonewtons
600 millimeters and over	49 kilonewtons

While under this load, the stressed joints shall show no leakage when subjected to an internal hydrostatic pressure of 35 kilopascals. At the option of the manufacturer, 1/2 of the load may be applied on the bell end of the suspended pipe in lieu of the full load on the center of the suspended pipe.

9-05.8 Vitrified Clay Sewer Pipe

This material shall not be used in Washington Department of Transportation projects unless specified in the special provisions.

Vitrified clay sewer pipe shall conform to ASTM C 700, and all joints shall be factory manufactured in accordance with ASTM C 425.

9-05.9 Steel Spiral Rib Storm Sewer Pipe

Steel spiral rib storm sewer pipe shall meet the requirements of AASHTO M 36M and these Specifications. The size, coating, metal, and protective treatment shall be as shown in the Plans or in the specifications.

The manufacturer of spiral rib storm sewer pipe shall furnish the Engineer a Manufacturer's Certificate of Compliance stating that the materials furnished comply in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor at no expense to the Contracting Agency.

Unless otherwise specified, spiral rib storm sewer pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe. Pipe ends shall be cut evenly. Spiral rib pipe shall be fabricated either by using a continuous helical lock seam or a continuous helical welded seam paralleling the rib.

Spiral rib storm sewer pipe shall have helical ribs that project outwardly, be formed from a single thickness of material, and conform to one of the following configurations:

1. AASHTO M 36M, Section 7.2.2.
2. 10 millimeters ± 3 millimeters wide by 11 millimeters (minimum) deep at 122 millimeters center to center.
3. 19 millimeters wide by 16 millimeters deep at 300 millimeters center to center.

Pipe shall be fabricated with ends that can be effectively jointed with coupling bands.

When required, spiral rib pipe shall be bituminous treated or paved. The bituminous treatment for spiral rib pipe shall conform to the requirements of Sections 9-05.4(3) and 9-05.4(4).

9-05.9(1) Continuous Lock Seam Pipe

Pipes fabricated with a continuous helical seam parallel to the rib may be used for full circle pipe. The seam shall be formed in the flat between ribs and shall conform to Sections 7.5.1 through 7.5.3 of AASHTO M 36M.

9-05.9(1)A Basis for Acceptance

The basis for acceptance will be a qualification test, conducted by the Olympia Service center Materials Laboratory, for each manufacturer of spiral rib lock seam steel pipe. Only those specific pipe sizes and gasket materials, if any, approved under the qualification test will be accepted.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249.

9-05.9(2) Continuous Welded Seam Pipe

Pipes fabricated with a continuous helical welded seam parallel to the ribs may be used for full circle pipe. The welding process for galvanized steel pipe shall be so controlled that the combined width of the weld and adjacent spelter coating burned by the welding does not exceed three times the thickness of the metal. If spelter is burned outside these limits, the weld and burned spelter shall be repaired as required for damaged galvanizing. Testing

for welded seam quality control shall conform to AASHTO T 241. Welded pipe fabricated from aluminized steel pipe shall have the coating of the welded area repaired by flame-sprayed metallizing inside and out after welding.

Repair of damaged galvanizing: When the galvanized (zinc coated) surface has been burned by gas or arc welding, all surfaces of the welded connections shall be thoroughly cleaned by wire brushing, and all traces of the welding flux and loose or cracked galvanizing removed, after which the areas shall be repaired by flame spray metallizing both inside and out.

9-05.9(3) Coupling Bands

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.10(1).

9-05.10 Steel Storm Sewer Pipe

Steel storm sewer pipe shall conform to the requirements of Section 9-05.4 for steel culvert pipe, except that protective coating shall be Treatment 5, and be constructed of either helically corrugated lock seam or helically corrugated continuous welded steel pipe. When gasketed helically corrugated lock seam steel pipe is called for, Treatment 5 is not required. Welded seam aluminum coated (aluminized) steel pipe shall require metallized aluminum coating inside and out following welding and shall not require Treatment 5.

9-05.10(1) Coupling Bands

Coupling bands shall be as shown in the Standard Plans. Bands shall be fabricated of the same material as the pipe and shall meet all applicable requirements of AASHTO M 36. Bands may be up to three nominal thicknesses thinner than used for the pipe, but not thinner than 1.6 millimeters or thicker than 2.8 millimeters. Bands shall be coated with the same metallic protective treatment as the pipe but shall not be coated with any asphalt treatment. Bands shall be made by the same manufacturer as the steel pipe selected for installation.

Corrugations on the bands shall be the same size and shape as those on the pipe to be connected. Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with AASHTO M 232. Steel angles, when required for coupling bands, shall meet the requirements of AASHTO M 36. When annular corrugated bands are used to connect helically corrugated lock-seam pipe, the seam shall be welded at the pipe ends prior to recorrugating to prevent unraveling of the seam. All welds shall develop the full strength of the parent metal.

Gaskets are required for all storm sewer installations. Gasket material for coupling bands shall meet the requirements of Section 9-04.4(3). Gaskets for Type D bands shall match the width of the band and have a minimum thickness of 9.5 millimeters. O-ring gaskets for Type F bands shall have a cross-sectional diameter of 20 millimeters for pipe diameters of 900 millimeters or smaller and 22 millimeters for larger pipe diameters.

Type K coupling bands are not allowed for storm sewer applications.

9-05.10(2) Basis for Acceptance

The basis for acceptance of steel storm sewer pipe will be the same as specified in Section 9-05.4, except when gasketed helically corrugated lock seam steel pipe is called for. A qualification test conducted by the Field Operations Support Service Center Materials Laboratory will be required for each manufacturer of gasketed helically corrugated lock seam steel pipe. Only those specific pipe sizes and gasket materials approved under the qualification test will be accepted.

9-05.11 Aluminum Storm Sewer Pipe

Aluminum storm sewer pipe shall conform to the requirements of Section 9-05.5 for aluminum culvert pipe, except that the protective coating shall be Treatment 5, and the pipe shall be constructed of helically corrugated lock seam aluminum pipe.

When gasketed helically corrugated lock seam aluminum pipe is called for, Treatment 5 is not required.

9-05.11(1) Coupling Bands

Coupling bands for aluminum pipe shall be as shown in the Standard Plans. Bands shall be fabricated of the same material as the pipe and shall meet all applicable requirements of AASHTO M 196, except the band thickness shall not be more than 2.7 millimeters or less than 1.5 millimeters. All other requirements of Section 9-05.10(1) shall apply.

9-05.11(2) Basis for Acceptance

The basis for acceptance of aluminum storm sewer pipe will be the same as specified in Section 9-05.0, except when gasketed helically corrugated lock seam aluminum pipe is called for. A qualification test, conducted by the Field Operations Support Service Center Materials Laboratory, will be required for each manufacturer of gasketed helically corrugated lock seam aluminum pipe. Only those specific pipe sizes and gasket materials approved under the qualification test will be accepted.

9-05.12 Polyvinyl Chloride (PVC) Pipe

9-05.12(1) Solid Wall PVC Culvert Pipe, Solid Wall PVC Storm Sewer Pipe, and Solid Wall PVC Sanitary Sewer Pipe

Solid wall PVC culvert pipe, solid wall PVC storm sewer pipe, and solid wall PVC sanitary sewer pipe and fittings shall be solid wall construction and shall conform to the requirements of ASTM D 3034 SDR 35 for pipe up to 375-millimeter diameter and ASTM F 679, Type 1 only, for pipe sizes 450- to 625-millimeter diameter.

Joints for solid wall PVC pipe shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477.

Fittings for solid wall PVC pipe shall be injection molded, factory welded, or factory solvent cemented.

9-05.12(2) Profile Wall PVC Culvert Pipe, Profile Wall PVC Storm Sewer Pipe, and Profile Wall PVC Sanitary Sewer Pipe

Profile wall PVC culvert pipe and profile wall PVC storm sewer pipe shall meet the requirements of AASHTO M 304M or ASTM F 794 Series 46. Profile wall PVC sanitary sewer pipe shall meet the requirements of ASTM F 794 Series 46. The maximum pipe diameter shall be as specified in the Qualified Products List.

Joints for profile wall PVC culvert pipe shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477, or as approved through the Olympia Service Center Materials Laboratory.

Qualified producers are identified in the Qualified Products List. Qualification for each producer requires joint system conformation to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477 and a formal quality control plan for each plant proposed for consideration.

A producer's Certificate of Compliance shall be required and shall accompany the materials delivered to the project. The certificate shall clearly identify production lots for all materials represented. The Contracting Agency may conduct verification tests of pipe stiffness or other properties as it deems appropriate.

Fittings for profile wall PVC pipe shall meet the requirements of AASHTO M 304M or ASTM F 794 Series 46.

9-05.13 Ductile Iron Sewer Pipe

This material shall not be used in Washington Department of Transportation projects unless specified in the special provisions.

Ductile iron pipe shall conform to ANSI A 21.51 or AWWA C 151 and shall be cement mortar lined, push-on joint, or mechanical joint. The ductile iron pipe shall be Class 50 or the class indicated on the Plans or in the Special Provisions.

Joints for ductile iron pipe shall be rubber gasketed conforming to the requirements of ANSI A 21.11 or AWWA C-111.

Cast iron fittings may be used with ductile iron pipe. Saddles fastened to pipe with external bands shall not be acceptable on any new system. Normally, all fittings shall be the same material as the pipe being connected, except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Engineer. Fittings shall have sufficient strength to withstand handling and load stresses normally encountered.

9-05.14 ABS Composite Sewer Pipe

This material shall not be used in Washington Department of Transportation projects unless specified in the special provisions.

ABS composite pipe shall meet the requirements of AASHTO M 264.

ABS composite pipe shall be provided with Type OR (flexible gasketed) joints. Rubber gasketed joints shall conform to applicable provisions of ASTM C 443M.

Fittings for ABS composite pipe shall be specifically designed for connection to ABS composite pipe with solvent cement. Normally, all fittings shall be the same material as the pipe being connected, except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Engineer. Fittings shall have sufficient strength to withstand handling and load stresses normally encountered.

9-05.15 Metal Castings

Metal castings for drainage structures shall not be dipped, painted, welded, plugged, or repaired.

Porosity in metal castings for drainage structures shall be considered a workmanship defect subject to rejection by the Engineer.

9-05.15(1) Manhole Ring and Cover

Castings for manhole rings shall be gray-iron conforming to the requirements of AASHTO M 105, Grade 30B. Covers shall be ductile iron conforming to ASTM A 536, Grade 80-55-06.

All covers shall be interchangeable within the dimensions shown in the Standard Plans. Manhole rings and covers shall meet the strength requirements of Federal Specification RR-F-621E. All mating surfaces shall be machine finished to ensure a nonrocking fit.

The horizontal surface and inside vertical recessed face of the ring, and the horizontal seating surface and vertical outside edge of the cover, shall be machine finished to the following tolerances:

Ring	+2.5 millimeters to -2.5 millimeters
Cover	+2.5 millimeters to -2.5 millimeters

All manhole rings and covers shall be identified by the name or symbol of the manufacturer and country of casting origin. This identification shall be in a plainly visible location when the ring and cover are installed. Ductile iron shall be identified by the following, "DUC" or "DI." The manufacturer's identification and material identification shall be adjacent to each other and shall be minimum 13 millimeters to maximum 25-millimeter high letters, recessed to be flush with the adjacent surfaces.

9-05.15(2) Metal Frame, Grate and Solid Metal Cover for Catch Basins or Inlets

Castings for metal frames for catch basins and inlets shall be cast steel, gray iron, or ductile iron as specified in Sections 9-06.8, 9-06.9, or 9-06.14, and as shown in the Standard Plans. Castings shall meet the strength requirements of Federal Specification RR-F-621E.

Castings for grates and solid metal covers for catch basins and inlets shall be cast steel or ductile iron as specified in Sections 9-06.8 or 9-06.14, and as shown in the Standard Plans. Castings shall meet the strength requirements of Federal Specifications RR-F-621E. The foundry name and material designation shall be embossed on the tope of the grate. The material shall be identified by the following: "CS" for cast steel or "DUC" or "DI" for ductile iron and shall be located near the manufacturer's name.

Grates and covers shall be seated properly to prevent rocking, including the replacement of existing covers with solid metal covers. After seating, the frame and grate or frame and cover shall be maintained as a unit. Alternate designs are acceptable provided they conform to the manufacture's shop drawings approved prior to award of the contract.

9-05.15(3) Cast Metal Inlets

The castings for cast metal inlets shall be cast steel or ductile iron as specified in Section 9-06.8 or Section 9-06.14 and as shown in the Standard Plans. Alternate plans are acceptable provided they conform to the fabricator's shop drawings approved prior to award of contract.

9-05.16 Grate Inlets and Drop Inlets

Steel in grates, angles, and anchors for grate inlets and drop inlets shall conform with AASHTO M 183M, except structural tube shall conform with ASTM A 500, Grade B. After fabrication, the steel shall be hot-dip galvanized with a minimum coating of 610 grams of zinc per square meter in accordance with AASHTO M 111 or galvanized with a hot-sprayed (plasma flame applied) 150 micrometers minimum thickness zinc coating.

Steel grating shall be fabricated by weld connections. Bearing bars and cross bars shall be resistance welded at the intersecting joints. Welds, welding procedures, and welding materials shall conform to Standard Specifications for Welding issued by the American Welding Society.

Alternate grate designs will be permitted, with the approval of the Engineer, providing the hydraulic capacity is not decreased, the overall dimensions are the same allowing the grate to be interchangeable, and the strength is essentially equal to the grate shown in the Standard Plan or the Plans.

The Contractor has the option of furnishing either cast-in-place or precast inlets unless otherwise shown in the Plans. Alternate designs are acceptable provided they conform to the fabricator's shop drawings approved prior to award of the contract.

9-05.17 Aluminum Spiral Rib Storm Sewer Pipe

Aluminum spiral storm sewer pipe shall meet the requirements of AASHTO M 196M and these Specifications. The size, metal, and protective treatment shall be as shown in the Plans or in the Specifications.

The manufacturer of spiral rib storm sewer pipe shall furnish to the Engineer a Manufacturer's Certificate of Compliance stating that the materials furnished comply in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor at no expense to the Contracting Agency.

Unless otherwise specified, spiral rib storm sewer pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe. Pipe ends shall be cut evenly. Spiral rib pipe shall be fabricated by using a continuous helical lock seam.

Spiral rib storm sewer pipe shall have helical ribs that project outwardly, be formed from a single thickness of material, and conform to one of the following configurations:

1. AASHTO M 196M, Section 7.2.2.
2. 10 millimeters ± 3 millimeters wide by 11 millimeters (minimum) deep at 120 millimeters center to center.
3. 19 millimeters ± 3 millimeters wide by 24 millimeters (minimum) deep at 295 millimeters center to center.
4. 19 millimeters wide by 16 millimeters deep at 300 millimeters center to center.

Pipe shall be fabricated with ends that can be effectively jointed with coupling bands.

When required, spiral rib pipe shall be bituminous treated or paved. The bituminous treatment for spiral rib pipe shall conform to the requirements of Sections 9-05.4(3) and 9-05.4(4).

9-05.17(1) Continuous Lock Seam Pipe

Pipes fabricated with a continuous helical lock seam parallel to the rib may be used for full circle pipe. The lock seam shall be formed in the flat between ribs and shall conform to Sections 13.2.1 through 13.2.5 of AASHTO M 196M.

9-05.17(1)A Basis for Acceptance

The basis for acceptance will be a qualification test, conducted by the Olympia Service Center Materials Laboratory, for each manufacturer of spiral rib lock seam pipe. Only those specific pipe sizes and gasket materials, if any, approved under the qualification test, will be accepted.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249.

9-05.17(2) Coupling Bands

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.10(1).

9-05.18 Safety Bars for Culvert Pipe

Steel pipe used as safety bars and steel pipe used as sockets shall conform to the requirements of ASTM A 53 for steel pipe. Steel tubing used as safety bars shall conform to ASTM A 500 for steel tubing. Steel plate shall conform to AASHTO M 183M. All parts shall be galvanized after fabrication in accordance with AASHTO M 111 and AASHTO M 232.

9-05.19 Corrugated Polyethylene Culvert Pipe

Corrugated polyethylene culvert pipe shall meet the requirements of AASHTO M 294 Type S for pipe 300 mm to 900 mm diameter or AASHTO MP6-95 Type S or D for pipe 1050 mm and 1200 mm diameter

Joints for corrugated polyethylene culvert pipe shall be made with either a bell/bell or bell and spigot coupling and shall incorporate the use of a gasket conforming to the requirements of ASTM D 1056, ASTM F 477, or ASTM D 5249. All gaskets shall be factory installed on the coupling or on the pipe by the producer. Qualified producers and approved joints are listed in the Qualified Products List.

Qualification for each producer of corrugated polyethylene culvert pipe requires an approved joint system and a formal quality control plan for each plant proposed for consideration.

A producer's Certificate of Compliance shall be required and shall accompany the materials delivered to the project. The certificate shall clearly identify production lots for all materials represented. The Contracting Agency may conduct verification tests of pipe stiffness or other properties as it deems appropriate.

9-05.20 Corrugated Polyethylene Storm Sewer Pipe

Corrugated polyethylene storm sewer pipe and fittings shall meet the requirements of AASHTO M 294 Type S. The maximum pipe diameter for corrugated polyethylene storm sewer pipe shall be the diameter for which a producer has submitted a qualified joint. Qualified producers are listed in the Qualified Products List. Fittings shall be blow molded, rotational molded, or factory welded.

All joints for corrugated polyethylene storm sewer pipe shall be made with a bell/bell or bell spigot coupling and shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477. All gaskets shall be factory installed on the pipe in accordance with the producer's recommendations.

Qualification for each producer of corrugated polyethylene storm sewer pipe requires joint system conformance to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477 and a formal quality control plan for each plant proposed for consideration.

A producer's Certificate of Compliance shall be required and shall accompany the materials delivered to the project. The certificate shall clearly identify production lots for all materials represented. The Contracting Agency may conduct verification tests of pipe stiffness or other properties as it deems appropriate.

9-06 STRUCTURAL STEEL AND RELATED MATERIALS

9-06.1 Structural Carbon Steel

Structural carbon steel shall conform to the requirements of AASHTO M 270M, Grade 250, Structural Steel for Bridges, unless the Plans, these specifications, or Special Provisions specify AASHTO M 183M, Structural Steel.

9-06.2 Structural Low Alloy Steel

Structural low alloy steel shall conform to the requirements of AASHTO M 270M, Grades 345 or 345W as specified in the Plans or Special Provisions, unless the Plans or Specifial Provisions specify AASHTO M 223M or M 222M as specified in the plans.

9-06.3 Structural High Strength Steel

Structural high strength steel shall be high yield strength, quenched and tempered structural steel conforming to the requirements of AASHTO M 270M, Grades 485W, 690, or 690W as specified in the Plans or Special Provisions, unless the Plans or Special Provisions specify AASHTO M 244M.

9-06.4 Vacant

9-06.5 Bolts

In lieu of the metric bolts, nuts, and washers specified, the Contractor may substitute English bolts, nuts, and washers, subject to the following conditions:

1. The substitution shall apply to all bolts, nuts, and washers furnished for the project. The Contractor shall not mix English and metric fasteners and hardware.
2. The English fasteners and hardware shall conform to the English AASHTO or ASTM material specification equivalent to the specified metric material specification.
3. The Contractor shall identify the material substitution on all shop plans submitted to the Engineer for approval, and on all Manufacturer's Certificate of Compliance submitted to the Engineer.
4. The Contractor shall make the substitution at no additional cost to the Contracting Agency.
5. The equivalent English unit hole size (standard, slotted, and oversize), and minimum spacing and edge distance dimensions, shall conform to the current editions of either the AASHTO Standard Specifications for Highway Bridges, or the AASHTO LRFD Bridge Design Specifications as appropriate for the design criteria specified in the Plans. Where the design criteria is not specified in the Plans, the provisions of the AASHTO Standard Specifications for Highway Bridges shall control.
6. The substitutions shall conform to the following table:

Metric Bolt Diameter in Plans		Equivalent English Bolt Diameter	
Bolt	**Std. Hole for High Strength Bolts (mm)**	**Bolt**	**Std. Hole for High Strength Bolts (inches)**
M5	N/A	$^{3}/_{16}$	N/A
M6	N/A	$^{1}/_{4}$	N/A
M8	N/A	$^{5}/_{16}$	N/A
M10	N/A	$^{3}/_{8}$	N/A
M12	N/A	$^{1}/_{2}$	N/A
M14	N/A	$^{9}/_{16}$	NIA
M16	18	$^{5}/_{8}$	$^{11}/_{16}$
M20	22	$^{3}/_{4}$	$^{13}/_{16}$
M22	24	$^{7}/_{8}$	$^{15}/_{16}$
M24	26	1	$1^{1}/_{16}$
M27	29	$1^{1}/_{8}$	$1^{3}/_{16}$
M30	32	$1^{1}/_{4}$	$1^{5}/_{16}$
M36	38	$1^{1}/_{2}$	$1^{9}/_{16}$

For anchor bolt diameters not covered by the table, the Contractor shall convert the metric diameter shown in the Plans to inches and furnish the anchor bolt in the nearest equivalent English diameter.

9-06.5(1) Unfinished Bolts

Unfinished bolts (ordinary machine bolts) shall conform to the specification requirements of ASTM A 307 Grade A or B. Nuts shall comply with ASTM A 563 Grade A requirements. Washers, unless otherwise specified, shall meet ASTM F 844 specifications.

The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of them.

9-06.5(2) Vacant

9-06.5(3) High Strength Bolts

High strength bolts for structural steel joints shall conform to the requirements of AASHTO M 164M or M 253M Type 1, 2, or 3.

Bolts conforming to AASHTO M 164M, having an ultimate tensile strength above 1000 MPa and are galvanized in accordance with AASHTO M 232, shall be tested for embrittlement. Embrittlement testing shall be conducted after galvanization in accordance with ASTM F 606M, Section 7. The Manufacturer's Certificate of Compliance for the lot provided shall show the ultimate tensile strength test results. Bolts conforming to AASHTO M 253M shall not be galvanized. AASHTO M 253M Type 1 and 2 bolts shall be painted with two coats of zinc rich paint, formula A-9-73, consisting of a minimum dry film thickness of 50 micrometers per coat.

Unpainted and nongalvanized bolts shall conform to AASHTO M 164M and M 253M Type 3.

Nuts for high strength bolts shall meet the following requirements:

AASHTO M 164M Bolts	
Black Type 1 and 2	AASHTO M 291M Class 8S, 8S3, 10S, and 10S3 AASHTO M 292M Grade 2H
Black weathering Type 3	AASHTO M 291M Class 8S3 and 10S3
Galvanized Type 1 and 2	AASHTO M 291M Class 10S AASHTO M 292M Grade 2H
AASHTO M 253M Bolts	
Black Type 1 and 2	AASHTO M 291M Grade 10S and 10S3 AASHTO M 292M Grade 2H
Black weathering Type 3	AASHTO M 291M Grade 10S3

Nuts that are to be galvanized shall be tapped oversized the minimum required for proper assembly. The amount of overtap shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291M and the rotational capacity test specified in AASHTO M 164M. The overtapping requirements of AASHTO M 291M Section 7.8 shall be considered maximum values.

Galvanized nuts shall be lubricated in accordance with AASHTO M 291.

Washers for AASHTO M 164M Type 1 and 3 bolts; and AASHTO M 253M Type 1, 2, and 3 bolts shall meet the requirements of ASTM F 436M. The surface condition and weathering characteristics of the washers shall be the same as for the bolts being specified.

Direct Tension Indicators shall conform to the requirements of ASTM F 959M and may be used with either AASHTO M 164M or AASHTO M 253M bolts. Direct tension indicators shall be galvanized by mechanical deposition in accordance with AASHTO M 298, Class 55. Hot dip galvanizing will not be allowed.

All bolts, nuts, and direct tension indicators shall be marked and identified as required in the pertinent specifications.

Lock-pin and collar fasteners which meet the materials, manufacturing, and chemical composition requirements of AASHTO M 164M or AASHTO M 253M, and which meet the mechanical property requirements of the same specification in full size tests, and which have a body diameter and bearing areas under lock-pin head and collar not less than those provided by a bolt and nut of the same nominal size may be used. The Contractor shall submit a detailed installation procedure to the Engineer for approval. Approval to use a lock-pin and collar fasteners will be given by the Engineer prior to use on these types of fasteners.

The Contractor shall provide Manufacturer's Certificate of Compliance for all bolts, nuts, washers, and load indicators. The Manufacturer's Certificate of Compliance shall include certified mill test reports and test reports performed on the finished bolt confirming that all of the materials provided meet the requirements of the applicable AASHTO or ASTM specification. The documentation shall also include the name and address of the test laboratory, the date of testing, the lot identification of the bolts and nuts, and coating thickness for galvanized bolts and nuts. Shipping containers (not lids) shall be marked with the lot identification of the item contained therein.

Bolts shall be sampled prior to incorporating into a structure. For the purposes of selecting samples, a lot of bolts shall be the quantity of bolts of the same nominal diameter and same nominal length in a consignment shipped to the project site. The minimum number of samples from each lot shall be as follows:

Lot Size	Sample Size[1,2]
0 to 50	*
51 to 150	4
151 to 1,200	6
1,201 to 10,000	10
10,001 to 35,000	16
35,001 and over	24

*Manufacturer's Certificate of Compliance — samples not required.

[1]If bolts are galvanized, increase the sample size by 1.5 times the table value for the number of bolts being sampled.

[2]Nuts, washers, and load indicator devices shall be sampled at the same frequency as the bolts.

All testing of bolts, nuts, washers, and load indicating devices shall be performed on specimens as they are to be installed.

All samples shall include a Manufacturer's Certificate of Compliance for each lot of bolts provided as defined in Section 1-06.3.

9-06.5(4) Anchor Bolts

Anchor bolts shall meet the requirements of ASTM A 449 or AASHTO M 164M. Galvanized anchor bolts having an ultimate tensile strength above 1000 Mpa shall be tested for embrittlement in accordance with ASTM A 143 unless the length is less than five times the nominal bolt diameter, then they shall be tested in accordance with ASTM F 606M, Section 7. The Manufacturer's Certificate of Compliance for the lot provided shall show the ultimate tensile strength test results.

Nuts for ASTM A 449 black anchor bolts shall conform to AASHTO M 291, Grade C. Nuts for ASTM A 449 galvanized bolts shall conform to AASHTO M 291, Grade DH and shall conform to the lubrication requirements in Section 9-05.4(3). Nuts for AASHTO M 164M black anchor bolts shall conform to AASHTO M 291, Grade 8S or AASHTO M292M, Grade 2H. Nuts for AASHTO M 164M galvanized anchor bolts shall conform to AASHTO M 291M, Grade 10S or AASHTO M 292M, Grade 2H. Washers for ASTM A 449 anchor bolts shall conform to AASHTO M 293M. Washers for AASHTO M 164M anchor bolts shall conform to ASTM F 436M.

The bolts shall be tested by the manufacturer in accordance with the requirements of the pertinent specification and as specified in these Specifications. Anchor bolts, nuts, and washers shall be inspected prior to shipping to the project site. The Contractor shall submit to the Engineer for approval a Manufacturer's Certificate of Compliance for the anchor bolts, nuts, and washers, as defined in Section 1-06.3. If the Engineer deems it appropriate, the Contractor shall provide a sample of the anchor bolt, nut, and washer for testing.

All bolts, nuts, and washers shall be marked and identified as required in the pertinent specification.

9-06.6 Vacant

9-06.7 Vacant

9-06.8 Steel Castings

Steel castings shall conform to the requirements of AASHTO M 103M, Mild to Medium Strength Carbon-Steel Castings for General Application, grade 485-250, unless otherwise designated in the Plans or in the Special Provisions.

9-06.9 Gray Iron Castings

Gray iron castings shall conform to the requirements of AASHTO M 105. The class of castings to be furnished shall be that designated in the Plans or in the Special Provisions.

9-06.10 Malleable Iron Castings

Malleable iron castings shall conform to the requirements of ASTM A 47M.

9-06.11 Steel Forgings and Steel Shafting

Steel forgings shall conform to the requirements of AASHTO M 102. The classes of forgings to be furnished shall be those specified in the Plans or in the Special Provisions.

Steel shafting shall conform to the requirements of AASHTO M 169, Grade Designation 1016 to 1030 inclusive, unless otherwise specified.

9-06.12 Bronze Castings

Bronze castings shall conform to the requirements of AASHTO M 107, Bronze Castings for Bridges and Turntables.

9-06.13 Copper Seals

Copper sheets for seals shall conform to the requirements of AASHTO M 138. They shall be UNS C12500, light cold rolled, and furnished in flat sheets each not less than 0.46 millimeters in thickness.

All splices or joints shall be carefully brazed or soldered to produce a continuous watertight seal for the full length of each unit.

9-06.14 Ductile Iron Castings

Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 80-55-06, unless otherwise specified in the Plans or in the Special Provisions.

9-06.15 Welded Shear Connectors

Welded shear studs shall be made from cold drawn bar stock conforming to the requirements of AASHTO M 169. Grades 1010 through 1020, inclusive, either semi-killed or killed deoxidation.

The material shall conform to the following mechanical properties:

Tensile Strength	420 megapascals min.
Yield Strength	350 megapascals min.
Elongation	20% min.
Reduction of Area	50% min.

Mechanical properties shall be determined in accordance with AASHTO Methods and Definitions T 244.

At the manufacturer's option, mechanical properties of the studs shall be determined by testing either the steel after cold finishing, or the full diameter finished studs.

9-06.16 Roadside Sign Structures

All bolts, nuts, washers, cap screws, and coupling botls shall conform to AASHTO M 164 and Section 9-06.5(3). All connecting hardware shall be galvanized after fabrication in accordance with AASHTO M 232.

Posts for single post sign structures shall meet the requirements of ASTM A 500 Grade B or ASTM A 53 Grade B, Type E or S.

Posts for multiple post sign structures shall meet requirements of AASHTO M 183M. Posts meeting the requirements of AASHTO M 222M, or AASHTO M 223M Grade 345 may be used as an acceptable alternate to the AASHTO M 183M posts. All steel not otherwise specified shall conform to AASHTO M 183M.

Triangular base stiffeners for one-directional multi-post sign shall meet the requirements of AASHTO M 222M or AASHTO M 223M Grade 345.

All steel, including posts, base plates, and base stiffeners, shall be galvanized after fabrication in accordance with AASHTO M111.

Base connectors for multiple directional steel breakaway posts shall conform to the following:

Brackets	Aluminum Alloy 6061 T-6
Bosses for Type 2B brackets	ASTM A 582
Anchor Ferrules	Type 304

Anchor couplings for multiple directional steel breakaway posts shall conform to AMS 6378D with a tensile breaking strength range as follows:

Type 2A	75 600N to 93 400N
Type 2B	209 000N to 253 500N

For multidirectional breakaway base connectors, shims shall conform to ASTM A 446M, Grade A, Coating Designation Z 450. For one-directional breakaway base connectors, single post or multi-post, shims shall be fabricated from brass conforming to ASTM B 36M.

9-06.17 Vacant

9-06.18 Metal Bridge Railing

Metal bridge railing shall conform to the type and material specifications set forth in the Plans.

Section 8, part (b) of the Aluminum Association Standard Specifications for Aluminum Railing Posts Alloy A 344-T4 is hereby revised to provide that no X-ray inspection will be required after a foundry technique has been established for each mold which will ensure production of castings which are free from harmful defects. Inspection for approval of castings will be made by the Engineer after the finished castings have been anodized as noted in the Plans.

Welding of aluminum shall be in accordance with Section 9-28.14(4).

9-06.19 Vacant

9-06.20 Vacant

9-06.21 Vacant

9-06.22 Bolts, Washers, and Other Hardware

Ordinary machine bolts and flat head bolts shall be made from commercial bolt stock meeting the specifications of ASTM A 307, and shall be grade A. Drift bolts and dowels may be either wrought iron or medium steel. Washers may be cast iron or malleable iron or may be cut from medium steel or wrought iron plate.

All bolts and other hardware which are to be galvanized and which require bending or shaping shall be hot forged to the required shape before galvanizing. Cold bending of such material will not be permitted because of the tendency toward embrittlement during the galvanizing process. Galvanizing shall be in accordance with AASHTO M 232.

Split rings for log cribbing of 100 millimeters inside diameter shall be manufactured from hot rolled, low-carbon steel conforming to ASTM A 711 AISI, Grade 1015. Each ring shall form a true circle with the principle axis of the cross-section of the ring metal parallel to the geometric axis of the ring. The thickness of the metal section shall be 4.95 millimeters plus or minus 0.25 millimeter and the section shall be beveled from the central portion toward the edges to a thickness of 3.7 millimeters plus or minus 0.25 millimeters. It shall be cut through in one place in its circumference to form a tongue and slot. Split ring connectors shall be galvanized in accordance with AASHTO M 232.

Spike-grid timber connectors shall be manufactured according to ASTM A 47M for malleable iron castings. They shall consist of 4 rows of opposing spikes forming a 105-millimeter square grid with 16 teeth which are held in place by fillets which are diamond shaped in cross-section.

Nails shall be round wire of standard form. Spikes shall be wire spikes or boat spikes, as specified in the Plans. Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified in the Plans, but if not so specified shall be galvanized when used in treated timber structures.

9-07 REINFORCING STEEL

9-07.1 General

9-07.1(1) Acceptance by Manufacturer's Certification

Reinforcing steel may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance.

9-07.1(2) Bending

Steel reinforcing bars shall be cut and bent by careful and competent workmen. They shall be bent cold to templates, which shall not vary appreciably from the shape and dimension shown in the Plans.

Hooks and bends of steel reinforcing bars shall be bent to the following inside diameters unless shown otherwise in the Plans:

Bar Size	Stirrups and Ties	All Other Bars
No. 3	40 mm	6 bar diameters
No. 4	50 mm	6 bar diameters
No. 5	65 mm	6 bar diameters
No. 6	115 mm	6 bar diameters
No. 7	135 mm	6 bar diameters
No. 8	150 mm	6 bar diameters
No. 9 through No. 11		8 bar diameters
No. 14 through No. 18		10 bar diameters

The supplementary requirements of AASHTO M 31M for bend tests shall apply to size No. 14 and No. 18 steel reinforcing bars which have hooks or bends.

9-07.1(3) Lengths

Net lengths of bent bars shown in the "LENGTH" column of the bar list in the plans are rounded to the nearest 25 millimeters. Net length is the length of bar after all bend deductions are subtracted from the gross length.

The following bend deductions per 90 degrees bend have been subtracted from the gross length:

Bar Size	Stirrups and Ties	All Other Bars
No. 3	20 mm	25 mm
No. 4	25 mm	30 mm
No. 5	30 mm	40 mm
No. 6	50 mm	50 mm
No. 7	55 mm	55 mm
No. 8	65 mm	65 mm
No. 9		85 mm
No. 10		95 mm
No. 11		105 mm
No. 14		145 mm
No. 18		195 mm

For bends other than 90 degrees, a direct proportion of these deductions will be used. The bend deductions listed will apply, except where bending radii are shown in the Plans.

For standard hooks on the ends of bars, the following hook lengths, in addition to the out to out detailed dimension, have been provided:

Length Added for One Hook (Millimeters)

	180° Hook	135° Hook		90° Hook	
Bar Size	**All Bars**	**Seismic Ties**	**All Other Bars**	**Stirrup and Ties**	**All Other Bars**
No. 3	130	125	90	75	130
No. 4	150	165	115	90	170
No. 5	175	205	145	110	215
No. 6	210	275	195	255	255
No. 7	245	320	230	300	300
No. 8	280	360	260	345	345
No. 9	380				405
No. 10	420				455
No. 11	470				505
No. 14	655				630
No. 18	875				840

9-07.1(4) Inspection

The provisions of Section 6-03.3(1) shall apply to the inspection of rolling and fabricating reinforcing steel.

9-07.2 Deformed Steel Bars

Deformed steel bars for concrete reinforcement shall conform to the requirements of AASHTO M 31, Deformed and Plain Billet Steel Bars for Concrete Reinforcement, Grade 60, or ASTM A 706M, Low-Alloy Steel, Deformed Bars for Concrete Reinforcement. However, in computing the ultimate unit tensile stress from test data, the area may be corrected for mass per meter of the bar within the mass tolerances listed. No such correction for mass shall be used in calculating the yield stress; the nominal area of the bar, as given in Table 1 of AASHTO M 31M or ASTM A 706M, shall be used in this computation.

Deformed steel bars are referred to in the Plans and specifications by number: for example, No. 3, No. 4, No. 5, etc.

9-07.3 Epoxy-Coated Steel Reinforcing Bars

Epoxy-coated rebars shall be coated according to AASHTO M 284M with the additional following modifications:

1. The list of steel reinforcing bars acceptable for coating shall include ASTM A 706M.
2. The Contractor shall furnish a written certification that properly identifies the material, the number of each batch of coating material used, quantity represented, date of manufacture, name and address of manufacturer, and a statement that the supplied coating material meets the requirements of AASHTO M 284M.
3. The Contractor shall supply to the Engineer a representative sample of 235 milliliters of the coating material from each batch. The sample shall be packaged in an airtight container and identified by batch number.

4. Prior to coating the bars, the Contractor shall submit to the Engineer for review, the coating material manufacturer's recommendation on the proper use and application requirements of the coating material.
5. A certification stating that all bars have been coated in accordance with the coating material manufacturer's recommendations and these Specifications shall be furnished with each shipment. This certification shall include for each bar size the preheat temperatures, cure times, thickness checks, holidays detected, and test results. Two copies of these certifications shall be furnished to the Engineer.
6. The Contractor shall give advance notice to the Engineer of the coating schedule in the coating plant so that Contracting Agency inspection may be provided. The Engineer may inspect the coated bars at the coating plant for approval.
7. The patching material, compatible with the coating material and inert in concrete, shall be supplied to the purchaser.
8. For projects where epoxy-coated steel reinforcing bars are used in the top mat of bridge decks only, the maximum amount of damage to the coating shall not exceed 0.25 percent of the surface area of each bar.
9. The thickness of epoxy-coating shall be 250 micrometers plus or minus 50 micrometers.
10. All samples shall be shipped to the Washington State Department of Transportation, Materials Laboratory, Tumwater, Washington 98504.

9-07.4 Plain Steel Bars

Where plain steel bars are specified, they shall conform to the chemical and physical properties of AASHTO M 31M, Grade 400, unless specifically noted otherwise. Plain steel bars are indicated in the Plans and specifications by millimeters; for example, 10 mm Ø, 13 mm Ø, 16 mm Ø, etc.

9-07.5 Dowel Bars (For Cement Concrete Pavement)

Dowel bars shall be plain steel bars of the dimensions shown it the *Standard Plans*. They shall conform to AASHTO M 31M, Grade 400 or AASHTO M 255M, Grade 400, and shall be coated in accordance with AASHTO M 284M. The ends of the bars shall be coated to a minimum of 100 micrometers. In addition, the requirements of Section 9-07.3, Items 2, 3, 4, 5, 6, 7, and 10 shall apply.

9-07.6 Tie Bars (For Cement Concrete Pavement)

Tie bars shall conform to the requirements of the Standard Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement, AASHTO M 31M, Grade 400 and shall be coated in accordance with AASHTO M 284M.

The form of the deformed bar shall be subject to approval by the Engineer.

Tie bars shall be free from dirt, grease, or other defects affecting the strength or bond with the concrete.

9-07.7 Wire Mesh

Wire mesh for concrete reinforcement shall conform to the requirements of AASHTO M 55, Welded Steel Wire Fabric for Concrete Reinforcement or AASHTO M 221, Welded Deformed Steel Wire Fabric for Concrete Reinforcement. All wire mesh shall be of an approved kind and quality of manufacture.

9-07.8 Deformed Wire

Deformed wire shall conform to the requirements of AASHTO M 225, Deformed Steel Wire for Concrete Reinforcement.

Deformed wire is noted in the Plans and specifications by the letter D, followed by a number indicating the cross-sectional area of the wire; for example, D2, D5, D20, etc.

9-07.9 Cold Drawn Wire

Cold drawn wire shall conform to the requirements of AASHTO M 32, Cold Drawn Steel Wire for Concrete Reinforcement.

Cold drawn wire is noted in the Plans and specifications by the letter W followed by a number indicating the cross-sectional area of the wire; for example, W2, W5, W20, etc.

9-07.10 Prestressing Reinforcement

Prestressing reinforcement shall be 12.70-millemeter diameter for precast-prestressed concrete piles and 12.70-millemeter or 15.24-millemeter diameter for pretensioned concrete girders, post-tensioned segmental precast concrete girders, or cast-in-place prestressed concrete.

Prestressing reinforcement shall be mill bright high-tensile-strength seven wire low-relaxation strand conforming to the requirements of AASHTO M 203M, Grade 1860.

All prestressing reinforcement furnished for a given structural member shall have a maximum elongation differential of 3 percent at stress of 0.8 of the ultimate strength of the prestressing steel. Each reel of prestressing reinforcement shall be accompanied by a Manufacturer's Certificate of Compliance, a mill certificate, and a test report. The mill certificate and test report shall include the chemical composition, the yield and ultimate strengths, elongation at rupture, modulus of elasticity, and the stress strain curve for the actual prestress reinforcing intended for use. All values certified shall be based on test values and actual sectional areas of the material being certified.

For each reel furnished, a sample, not less than 1.5 meters long, shall be sent to the Materials Laboratory, State of Washington, P.O. Box 167, Olympia, Washington 98504, for testing.

9-08 PAINTS

9-08.1 Raw Materials

The acceptance of particular lots of raw materials shall in no way obligate the Engineer to accept lots of finished paint that do not conform to the requirements of these Specifications. When not specifically detailed, the raw materials shall meet the requirements of the applicable Federal Specification in effect at the time of manufacture. Products not covered by State or Federal Specifications shall be of top quality, meeting prevailing commercial standards. Raw materials for paints shall conform to the requirements of the specifications listed below.

Alkyd resin solution, Federal TT-R-266, Type I or Type II.

Aluminum paste, ASTM D 962, Type 2, Class B. Paints made with the paste shall be smooth and highly lustrous.

Anti-skinning agent shall have no deleterious effect on the drying time of the finished paint. It shall effectively prevent skinning when added in the amounts specified in each formula and tested in accordance with Federal Test Std. No. 141a, Method 3021.

Aromatic petroleum thinner — water white low aniline petroleum solvent Kauri-Butanol value ..... 70 (min.)

Barium sulfate pigment, ASTM D 602.

Chrome oxide green, ASTM D 263. The tinting properties shall be such that the standard color of the formulas using chrome oxide green can be produced without departing from the limits of composition given in those formulas.

Chrome yellow pigment and paste, ASTM D 211, Type III.

Fibrous magnesium silicate (talc), ASTM D 605.

Lampblack pigment and paste, ASTM D 209.

Liquid drier, ASTM D 600.

Mineral spirits, ASTM D 235.

Raw linseed oil, ASTM D 234.

Red iron oxide pigment, ASTM D3721, D3722 & D3724.

Silica shall be finely ground amorphous or crystalline material. It shall have a maximum oil absorption of 50 when tested in accordance with ASTM D 281.

Soya lecithin shall be pure.

Spar varnish, Federal TT-V-119.

Titanium pigments, ASTM D 476. Titanium dioxide for use in exterior white paints shall conform to Type II. Titanium pigments used in tinted paints and enamels shall be exterior chalk resistant, Type III.

Turpentine shall be gum spirits of turpentine, ASTM D 13.

Yellow iron oxide, hydrated, ASTM D 768.

Zinc oxide pigment and paste, ASTM D 79.

Zinc yellow (zinc chromate), ASTM D 478.

Raw materials not specifically covered shall meet current Federal specifications for said material.

9-08.2 Paint Formulas — General

All paints shall be made from materials meeting the requirements specified in Section 9-08.1. The paint shall be made in accordance with the following formulas and shall meet the requirements set forth above as well as the special requirements set forth for each

formula. The formulas are stated in terms of dry pigment. Each formula shall contain the specified raw materials which shall be proportioned to give the compositions in percentages by mass or parts by mass, as shown in the formulas that follow.

Formula A-5-61 — Vinyl Pretreatment

The primer shall meet the requirements of Federal Specification MIL-P-15328B or MIL-P-15328C, Primer Pretreatment (Formula 117B for Metals).

Vinyl Wash Primer shall be mixed by adding 1 volume of acid component (diluent) to 4 volumes of resin component (base solution) slowly and with constant stirring. The material shall be used within 8 hours of mixing. The wash primer coat shall be spray applied to all surfaces at a coverage rate of 0.14 to 0.16 liters per square meter to yield a dry film of 13 to 23 micrometers thickness. If necessary to maintain a wet spray, additional thinning with normal Butanol or 99 percent Isopropanol will be allowed. Acid component above the required amount shall not be used for thinning. A drying time of one hour is required before recoating.

1. Butanol shall meet Federal Specification TT-B-846b Butyl Alcohol; Normal.
2. Isopropanol (99 percent) shall conform to ASTM D 770 Isopropyl Alcohol.

Formula A-6-86 Zinc Dust Zinc Oxide Primer

The primer shall meet the requirements of Federal Specification TT-P-641 Primer — Paint: Zinc Dust-Zinc Oxide Type III.

Formula A-9-73 — Galvanizing Repair Paint, High Zinc Dust Content

The galvanizing repair paint shall meet the requirements of Federal Specification MIL-P-21035 (Ships) Paint, High Zinc Dust Content, Galvanizing Repair.

Formula C-6-90 — Green Phenolic Finish Coat for Steel

Zinc chromate (dry pigment)	13.8 parts
Chrome green oxide (dry pigment)	16.1 parts
Titanium dioxide (dry pigment)	16.7 parts
Yellow iron oxide (dry pigment)	1.3 parts
Fibrous magnesium silicate (dry pigment)	5.0 parts
Aluminum stearate (dry pigment)	0.2 parts
Spar varnish	22.1 parts
Raw linseed oil	21.4 parts
Driers	1.0 parts
Anti-skinning agent	0.1 parts
Mineral spirits	2.3 parts
Mass per liter (minimum)	1.5 kilograms
Viscosity at 21°C	80 ± 8 K.U.
Grind (minimum)	6
Set to touch	4 hours
Dry hard	18 hours
Sag Index	7 min.
Test Requirements: Prior to shipment.	
Viscosity Adjustment: Mineral spirits to be added at the factory to achieve the specified viscosity.	

The proportions of tinting pigments may be varied to achieve the desired color. The color of the paint when dry must match the color of a standard C-6-90 color chip. Additional tinting pigments may be required.

Formula C-9-90 — Phenolic Finish Coat for Steel

Zinc Oxide (dry pigment)	10.0 parts
Titanium Dioxide (dry pigment)	21.0 parts
Fibrous Magnesium Silicate (dry pigment)	3.2 parts
Barium Sulfate (dry pigment)	12.8 parts
Tinting Pigments	5.9 parts
Treated Bentonite Clay (dry pigment)	0.2 parts
Anti-Sag Agent	1.9 parts
Raw Linseed Oil	12.6 parts
Spar Varnish	29.0 parts
Anti-Skin Agent	0.1 parts
Driers	1.0 parts
Mineral Spirits	1.8 parts
Xylene	0.5 parts
Mass per liter (minimum)	1.47 kilograms
Viscosity 21°C	80 ± 8 K.U.
Dry Hard (maximum)	18 hours
Set to Touch (maximum)	4 hours
Grind (N.S.) (minimum)	5
Sag Index (minimum)	4
Total Solids by Mass	80 ± 5%
Test Requirements: Prior to shipment.	

Adjustments for tinting pigments and talc, solvents and chemical additives shall be made at the factory to achieve the desired color and physical characteristics. A fungicide, N-(Trichloromethylthio) phthalimide shall be added at the rate of 1 kilogram per 275 liters.

C-10-83 — Vinyl Finish Coat

Vinyl Finish Coat shall conform to the following specifications:

Pigment (12 Percent Minimum by Mass)

A combination of titanium dioxide and colored pigments or a combination of colored pigments such that the resultant paint when dry matches the color sample available at the Project Engineer's office.

Vehicle (88 Percent Maximum by Mass)

Vinyl Resin Type II[1]	9.1 parts
Vinyl Resin Type III[2]	9.1 parts
Tricresyl Phosphate	3.4 parts
Methyl Isobutyl Ketone	39.2 parts
Toluene	39.2 parts
	100.0

[1]Vinyl Resin Type II shall be hydroxyl containing vinyl chloride-acetate copolymer. It shall contain 89.5 to 91.5 percent (by mass) vinyl chloride, 2.0 to 5.5 percent vinyl acetate and 5.3 to 7.0 percent vinyl alcohol. It shall produce results in the specified formulations equal to the Bakelite Corporation Vinylite resin VAGH.

[2]Vinyl Resin Type III shall be a vinyl chloride-acetate co-polymer of medium average molecular mass and shall contain 85 to 88 percent vinyl chloride and 12 to 15 percent vinyl acetate by mass. It shall produce in the specified formulations results equal to Bakelite Corporation Vinylite resin VYHH.

Lampblack shall be ground in the Vinyl Finish Coat vehicle to yield a smooth well ground paint, Black Vinyl Tinting Paste, satisfactory for tinting either the Vinyl-Red Lead Primer or Vinyl Finish Coat.

The Vinyl Finish Coat and Vinyl Tinting Paste shall be ground to a fineness of not less than 5 when testing in accordance with Federal Test Method Standard No. 141b, Method 4411.1.

Vinyl Thinner shall be composed of the following materials:

Toluene	90 percent by volume
Methyl Isobutyl Ketone	10 percent by volume

The paints as received will require thinning with from 20 to 35 percent by volume of Vinyl Thinner to maintain a wet spray.

Formula D-1-57 — Aluminum Paint

Aluminum paste Type 2 Class B	0.9 kilogram
Spar Varnish	3.8 liters

Aluminum paint shall be mixed on the job site, and only enough for one day shall be mixed at a time. The weighed amount of paste shall be placed in a suitable mixing container and the measured volume of vehicle then poured over it. The paste shall be incorporated by vigorous stirring with a paddle.

Test Requirements: Prior to mixing.

Formula D-4-57 — Black Enamel

The enamel shall meet the requirements of Federal TT-E-529 Black Enamel, Synthetic, Semi Gloss.

Test Requirements: This enamel will be sampled and tested in the ready-mixed form.

Formula D-5-83 — White Guardrail Paint (Alkyd Vehicle)

Titanium dioxide (dry pigment)	28.1 parts
Zinc oxide (dry pigment)	10.9 parts
Fibrous magnesium silicate (dry pigment)	4.3 parts
Aluminum stearate (dry pigment)	0.5 parts
Alkyd vehicle	37.0 parts
24% lead naphthenate drier	0.4 parts
6% Cobalt naphthenate drier	0.2 parts
6% Manganese naphthenate drier	0.2 parts
Anti-skinning agent	0.2 parts
Mineral spirits	18.2 parts
Mass per liter (minimum)	1.32 kilograms
Viscosity at 21°C	80-90 K.U.
Nonvolatile content (minimum)	70.2%
Grind (minimum)	4
Hiding power (maximum scale reading)	30
Set to touch	4 hours
Dry hard	18 hours
Sag Index	7 min.

Test Requirements: Prior to shipment.

Viscosity Adjustment: Mineral spirits will be added at the factory to achieve the specified viscosity.

This formula is to be used over primed or previously painted surfaces.

Formula E-1-57 — White for Wood Structures

The material shall conform to Federal TT-P-102, Class A.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

Primer: Turpentine may be added to the above paint in quantities not to exceed 187 milliliters per liter of paint for use as a primer.

Formula E-2-62 — Primer for Wood

The primer shall be a ready mixed priming paint for use over unpainted wood surfaces. It shall meet the requirements of Federal Specification TT-P-25 Primer, Paint, Exterior.

Test Requirements: This paint shall be sampled and tested in the ready mixed form.

Formula F-3-64 — Orange Equipment Enamel

The enamel shall meet the requirements for Enamel, Alkyd, Gloss, Federal Specification TT-E-489, except that the Sag Index shall be seven minimum. The color, when dry, shall match that of Federal Standard No. 595, color 12246.

Test Requirements: When manufactured on Contract or Purchase Order for maintenance use, the enamel will be sampled and tested in the ready-mix form. No factory inspection will be required; however, a 500-milliliter sample representing the batch must be submitted to the Materials Laboratory for approval before use.

For factory application to individual items of new equipment, samples of the enamel will not be required; however, the equipment manufacturer must match the color and certify the quality of enamel used.

Formula H-1-83 — Primer for Concrete

Titanium dioxide	5.0 parts
Calcium carbonate	19.7 parts
Fibrous magnesium silicate	6.8 parts
Silica	6.8 parts
Spar varnish	52.3 parts
Mineral spirits	9.4 parts
Mass per liter (minimum)	1.17 kilograms
Drying time (for testing purposes only)	18 hours
Viscosity at 21°C	65-75 K.U.

Consistency: The paint shall not thicken after manufacture to an extent sufficient to impair its brushing qualities.
Test Requirements: Prior to shipment.

Formula H-2-83 — White Masonry Paint for Precast Curbs

Titanium dioxide (dry pigment)	11.9 parts
Calcium carbonate (dry pigment)	25.6 parts
Mica (dry pigment)	7.4 parts
Diatomaceous silica (dry pigment)	7.0 parts
Bentone (body agent)	0.5 parts
Pliolite S5-A	8.0 parts
Chlorinated Paraffin 40%	4.0 parts
Chlorinated Paraffin 70%	4.0 parts
Aromatic brushing thinner	31.6 parts
Viscosity at 21°C	90-100 K.U.
Mass per liter (minimum)	1.45 kilograms
Drying time (for test purposes only)	18 hours

Test Requirements: Prior to shipment.

Formula H-3-83 — Yellow Masonry Paint for Precast Curbs

Titanium dioxide (dry pigment)	1.0 parts
Medium chrome yellow (dry pigment)	10.9 parts
Calcium carbonate (dry pigment)	25.6 parts
Mica (dry pigment)	7.4 parts
Diatomaceous silica (dry pigment)	7.0 parts
Bentone (body agent)	0.5 parts
Pliolite S5-A	8.0 parts
Chlorinated paraffin 40%	4.0 parts
Chlorinated paraffin 70%	4.0 parts
Aromatic brushing thinner	31.6 parts
Viscosity at 21°C	90-100 K.U.
Mass per liter (minimum)	1.45 kilograms
Drying time (for test purposes only)	18 hours

Test Requirements: Prior to shipment.

Formula K-1-83 — Exterior Acrylic Latex Paint-White

This paint shall meet the requirements of Federal Specification TT-P-19, Paint, Acrylic Emulsion, Exterior, except that the viscosity shall be 75-85 K.U.

This paint may be used self-primed in multiple coats over salts treated wood and on interior and exterior masonry surfaces.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

Formula K-2-83 — Traffic Signal Yellow Enamel

Traffic signal yellow enamel shall meet the provision of Federal Specification TT-E-489 — Enamel, Alkyd, Gloss — and shall match the color of "Standard Interstate Yellow."

Formula A-11-99 Primer, Zinc Filled Single Component, Moisture-Cured Polyurethane

Zinc rich primer shall meet the following requirements:

Vehicle Type: Moisture-cured polyurethane
Pigment Content: 80% minimum zinc by weight in dry film.
Volume Solids: 60% plus or minus 3%.
Mass per liter (minimum) 2.63 kilograms.

Formula B-11-99 Intermediate and Stripe Coat, Single Component, Moisture Cured Polyurethane

Vehicle Type: Moisture-cured polyurethane
Pigment: Mass per liter (minimum) 0.36 kilograms of micaceous iron oxide per gallon.

Intermediate and any stripe coat shall meet the following requirements:

Minimum volume solids 50%.
Mass per liter (minimum) 0.36 kilograms of micaceous iron oxide.
The intermediate coating must be certified by the manufacturer to be able to be recoated by the top coat in a minimum of 4 days.

When used as a universal primer on previously painted surfaces, the intermediate coat must not lift the undercoats and must adhere well to the painted surface, to bare steel, aluminum, or galvanized surfaces.

Formula C-11-99 Top Coat Single Component, Moisture Cured Polyurethane

Vehicle Type: Moisture-cured aliphatic polyurethane
Color: Match Federal Standard 595a

The Top Coat shall meet the following requirements:

The resin must be an aliphatic urethane.
Minimum volume solids 50%.
The top coat shall be a gloss.

Any evidence of aromatic rings, or more than 0.7% free isocyanate monomer as a percent of total solids will not be accepted.

9-08.3 Inspection Requirements General

The manufacturer shall notify the Engineer of the date on which manufacture will be started, and the Engineer shall have the right to inspect all details of the manufacturing process.

Quantities of 75 liters or less of the above formulas will be accepted without inspection upon the manufacturer's notarized certificate. This certificate shall contain a statement by the manufacturer to the effect that the material meets the formula specification, and shall include a list of materials and quantities used. One copy of the certificate shall accompany the paint when shipped and one copy with a sample of the paint shall be sent to the Materials Laboratory. The paint may be used at once without further release from the Materials Laboratory.

9-08.4 Process of Manufacture

The following process of manufacture shall be used for each paint except aluminum paint. Pigments shall be ground thoroughly in appropriate portions of the specified vehicle to form a paste meeting the requirements set forth in Section 9-08.4(6).

The grinding shall be done in a mill approved by the Engineer. The use of the "colloid" type of mill will not be approved. Weighed quantities of the paste and weighed or measured quantities of the vehicles shall then be mixed thoroughly and strained, if necessary, to form a paint free from skins, lumps, and foreign materials.

9-08.4(1) Viscosity Adjustment

The volatile thinner content of the paint shall be adjusted at the factory to meet the required viscosity, but in no case shall the resultant mass per liter and nonvolatile content of the paint be below that specified in the formula.

9-08.4(2) Mass Variations

The mass per liter of the paint in any lot shall not be less than that stated in the formula. A "lot" as used in this section shall be the quantity of paint ground at one time by any one mill.

9-08.4(3) Drying Time and Quantity of Drier

The paint shall dry within the length of time stated in each formula but shall not contain sufficient quantities of drier to cause the paint to dry to a nonuniform or nonelastic film. The manufacturer will be permitted to vary the quantity of drier given in the formula sufficiently to accomplish the above results.

9-08.4(4) Working Properties

The paint shall contain no caked material that cannot be broken up readily by stirring. When applied to a clean vertical surface, the paint shall dry without running, streaking, or sagging.

9-08.4(5) Storage Properties

Paints manufactured under these Specifications shall show no skin over the surface after 48 hours in a partially filled container, when tested as outlined in Federal Test Method Standard No. 141. A slight amount of skin or gel formation where the surface of the paint meets the side of the container may be disregarded. Variable percentages of anti-skinning agents are shown in those formulas set forth above that are susceptible to undesirable skin formation. The manufacturer will be allowed to vary the amount of anti-skinning agent given in the formulas provided the above results are accomplished and provided the paint does not dry to a nonuniform or nonelastic film.

9-08.4(6) Fineness of Grinding

The paint shall be ground so that all particles of pigment will be dispersed and be coated with vehicle, and the residue on a 0.045-millimeter sieve will not exceed 1 percent by mass of the pigment.

9-08.4(7) Standard Colors

When the paint is required to match a standard color, the manufacturer may obtain a sample of the required color without cost upon application to the Materials Laboratory, P.O. Box 167, Olympia, Washington 98504.

9-08.4(8) Containers

Each container shall be filled with paint and sealed airtight. Each container shall be filled with the amount of paint required to yield the specified quantity when measured at 21°C.

All paint shall be shipped in new suitable containers having a capacity not greater than 19 liters. Each container shall be marked with a suitable number to identify the particular batch from which it was filled.

9-08.5 Test Methods

As set forth in Section 9-08.2, all paints shall meet the special requirements set forth for each formula. The test methods used to check those special requirements shall be as specified in the Washington State Department of Transportation *Materials Manual* or the corresponding test method covered by Federal Test Method Standard No. 141. When test methods are not covered by the above, applicable ASTM methods shall be followed.

9-08.6 Shipping

Except for lots of paint in quantities of 75 liters or less which are accepted upon the manufacturer's certificate, the manufacturer shall not ship any lot of paint until the paint has been tested and released by the Washington State Department of Transportation Olympia Service Center Materials Laboratory. This release will not constitute final acceptance of the paint. Final acceptance will be based on inspection or testing of job site samples as determined by the Engineer.

9-08.7 Field Samples

Because of the volatility of the solvents used in the paint, the upper limit on viscosity shall be waived on all paint samples taken in the field.

9-09 TIMBER AND LUMBER

9-09.1 General Requirements

All timber and lumber for structures shall be Douglas Fir-Larch, unless specified otherwise in the contract. The allowable species of timber and lumber for guardrail posts shall be Douglas Fir-Larch or Hem Fir. Timber and lumber for sign posts, mileposts, sawed fence posts, and mailbox posts, shall be Western Red Cedar, Douglas Fir-Larch, or Hem-Fir.

9-09.2 Grade Requirements

Timber and lumber shall conform to the grades and usage listed below. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA)

Structures

Timber and lumber, unless specified otherwise in the contract, shall conform to the following:

Materials 38 mm thick, 114 mm and wider (Structural Joists and Planks)	No. I & better, grade (section 123-b of WCLIB) or (section 62.11 of WWPA)
Materials 114 mm and thicker (Beams and Stringers)	No. I & better, grade (section 130-b of WCLIB) or (section 70.11 of WWPA)

Timber lagging for soldier pile walls shall be Douglas Fir-Larch, grade No. 2 or better.

Guardrail Posts

Timber and lumber for guardrail posts (classified as Posts and Timbers) shall conform to the species and grades listed below.

Douglas Fir	No. I & better, grade (section 131-b WCLIB) or (section 80.1 I WWPA)
Hem Fir	Select Structural, grade (section 131-a WCLIB) or (section 80.10 WWPA)

Sign posts, Mileposts, Sawed Fence Posts, and Mailbox Posts

Sign posts, mileposts, sawed fence posts, and mailbox posts shall conform to the grades shown below.

4×4	Construction grade (Light Framing, section 122-b WCLIB) or (section 40.11 WWPA)
4×6	No. I & better, grade (Structural Joists and Planks, section 123-b WCLIB) or (section 62.11 WWPA)

6 × 6, 6 × 8, 8 × 10	No. I & better, grade (Posts and Timbers, section 131-b WCLIB) or (section 80.11 WWPA)
6 × 10, 6 × 12	No. I & better, grade (Beams and Stringers, section 130-b WCLIB) or (section 70.11 (WWPA)

9-09.2(1) Surfacing and Seasoning

All timber and lumber shall be sized as indicated in the plans.

All timber and lumber to be painted shall, be surfaced on all sides. All timber and lumber to be painted shall be thoroughly air or kiln dried to an equilibrium moisture content and shall be stored in such a manner as to remain in a thoroughly dry condition until placed into the work.

9-09.2(2) Vacant

9-09.2 (3) Inspection

Timber and lumber must be marked with a certified lumber grade stamp provided by one of the following agencies:

West Coast Lumber Inspection Bureau (WCLIB)
Western Wood Products Association (WWPA)
Pacific Lumber Inspection Bureau (PLIB)
Any lumber grading bureau certified by the American Lumber Standards Committee

A grading certificate must accompany each order of timber and lumber for use in structures as specified in Section 9-09.2. The certificate shall be issued by either the grading bureau whose stamp is shown on the material, or by the lumber mill, which must be under the supervision of one of the grading bureaus listed above. The certificate shall include the following:

Name of the mill performing the grading
The grading rules being used
Name of the person doing the grading with current certification
Signature of a responsible mill official
Date the lumber was graded at the mill
Grade, dimensions, and quantity of the timber or lumber

When the material is delivered to the project, the Engineer shall check the order for the appropriate grade stamp. The invoice and grading certificate accompanying the order must be accurate and complete with the information listed above. The grading certificate and grade markings shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the specifications or has been damaged during shipping or upon delivery.

9-09.3 Preservative Treatment

9-09.3(1) General Requirements

All timber and lumber requiring preservative treatment shall be treated in accordance with AASHTO M 133. As specified by AASHTO M 133, the American Wood-Preservers' Association (AWPA) standards shall govern the specifications. These specifications include: storing and curing the timber and lumber, the wood preservatives, the preservative treatment process, documenting the results of the treatment, inspection, testing, and the identification of properly treated timber. Unless otherwise specified in the contract, all timber and lumber shall be treated in accordance with Section C-l 4 of the latest addition of the AWPA standards.

All cutting, boring, chamfering, routing, surfacing, and trimming shall be done prior to treating. Any field drilling or cutoffs shall be treated by two liberal applications of a compatible preservative. The applications shall be in accordance with the requirements of AWPA Standard M-4 entitled, "Standard for the Care of Pressured Treated Wood Products".

All charges shall consist of pieces of the same species that are similar in form, size, moisture content, and receptivity to treatment. The pieces in the charge shall be separated to insure contact of treating medium with all surfaces. The method of determining the retention of the preservatives shall be by assay.

As specified in the contract, all orders of treated timber and lumber will be stamped "WSDOT Approved for Shipment" or accompanied by a Certificate of Treatment record. The Certificate of Treatment shall include the following information:

Name and location of the wood preserving company
Customer identification
Date of treatment and charge number
Type of chemical used and amount of retention
Treating process and identification of the specification used
Description of material that was treated
Signature of a responsible plant official

In addition to the Certificate of Treatment, all orders of treated timber or lumber that are not stamped "WSDOT Approved for Shipment", shall be accompanied by a Grading Certificate in accordance with Section 9-09.2(3). Such certification or approved for shipment tag shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the specifications or has been damaged during prolonged storage, shipping, or upon delivery.

All timber and lumber to be used in aquatic environments, unless specified otherwise in the contract, shall be chemically treated using Best Management Practices (BMP's). The producer of the chemically treated products shall supply a written certification that the BMP's were utilized, including a description and appropriate documentation of the BMP's used. This information may be included on the Certificate of Treatment record.

9-10 PILING

9-10.1 Timber Piling

Timber piling shall be untreated or treated with the preservatives specified in the Plans and completely described in Section 9-09.3.

Timber piles shall have the following limiting diameters:

Length in Meters	Min. Butt Dia. 1 meter above Butt in Millimeters	Max. Butt Dia. 1 meter above Butt in Millimeters	Min. Tip Dia. in Millimeters
Under 12	305	510	175
12-16.5	305	510	175
17-22.5	330	510	175
Over 22.5	355	510	175

Timber piles shall be strapped with at least three straps: one approximately 450 millimeters from the butt, one approximately 600 millimeters from the butt, and one approximately 300 millimeters from the tip. Additional straps shall be provided at approximately 4-meter centers between the butt and tip. Strapping shall encircle the pile once and be tensioned as tightly as possible. Straps shall be 32 millimeters wide, 0.79 millimeters thick, cold rolled, fully heat treated, high tensile strapping, painted, and waxed, with an ultimate tensile strength of 23 kilonewtons. The seal shall be 55 millimeters long, 20 gage, crimped with a notch type sealer to furnish a joint yielding 80 percent of the strap tensile strength. Treated timber piles shall be strapped after treatment.

9-10.1(1) Untreated Piling

Except where specifically provided otherwise, untreated timber piling shall be Douglas fir, Western red cedar, or larch. Piling for foundations shall be Douglas fir. Piling shall be cut from sound, live trees and shall contain no unsound knots. Sound knots will be permitted, provided the diameter of the knot does not exceed 100 millimeters, or $^1/_3$ of the small diameter of the pile at the point where they occur, whichever is smaller. Any defect or combination of defects which will impair the strength of the pile more than the maximum allowable knot will not be permitted.

Piling shall be cut above the butt swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than one percent of the length of the pile. A spiral grain or twist in excess of $^1/_4$ turn in 3 meters of length will be cause for rejection.

Untreated timber trestle piling shall have an average of at least five annual rings per 25 millimeters measured radially over a distance of 75 millimeters at the butt, beginning at a point 85 millimeters from the heart. At least 225 millimeters of heartwood shall show at the butt.

Ring count requirements for untreated timber foundation piling and detour trestle piling will be waived.

9-10.1(2) Creosote Treated Piling

For creosote treated piling, Douglas fir timber shall be used. All other requirements shall be the same as for untreated piling, except that the ring count requirement will be waived.

9-10.1(3) Timber Composite Piling

Timber composite piling shall consist of a pile made up of two timber sections. The lower section shall be untreated, and the upper section shall be creosote treated.

The treated and untreated sections of timber composite pile shall meet the respective requirements specified above for full length of treated and untreated timber piling.

9-10.1(4) Peeling

Untreated and creosote treated piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of inner bark remaining on the pile shall be over 20 millimeters wide or over 200 millimeters long, and there shall be at least 25 millimeters of clean wood surface between any two such strips. Not less than 80 percent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile.

9-10.2 Concrete Piling

9-10.2(1) Concrete

Cement meeting the requirements of Section 9-01 shall be used in all precast concrete piles.

The concrete for precast-prestressed piles shall conform to the requirements of Section 9-19.1. The concrete for prestressed piles shall have a minimum compressive strength of 41 megapascals at the age of 28 days. The minimum compressive strength of concrete at the transfer of prestress shall be 23 megapascals.

The concrete for other precast piles shall be Class 28. Mixing, transporting, and placing concrete shall be in accordance with the provisions of Section 6-02.3.

The Contractor shall mold and test a sufficient number of concrete test cylinders to determine the strength of the concrete as required by the specifications. Under the surveillance of the Engineer, the test cylinders shall be molded, cured, and tested in accordance with the procedures established by the Olympia Service Center Materials Laboratory.

In the event that a sufficient number of concrete test cylinders are not molded to satisfy all testing required on any one pile, cores measuring 100 millimeters in diameter by 125 millimeters in height shall be taken and tested by the Contractor. If the strength of the core meets the required compressive strength of the concrete, the pile may be accepted. The coring and testing of the core shall be done under the surveillance of the Engineer.

9-10.2(2) Reinforcement

Reinforcement shall meet the requirements of Section 9-07.

9-10.3 Cast-in-Place Concrete Piling

Reinforcement for cast-in-place concrete piles shall conform to the requirements of AASHTO M 31M Grade 300 or Grade 400.

9-10.4 Steel Pile Tips and Shoes

Steel pile tips and shoes shall be fabricated of cast steel conforming to ASTM A 148 Grade 60-90 [620-415] or ASTM A 27 Grade 65-35 [450-240] and be free from any obvious defects. Pile tips shall be accompanied by a mill test report stating the chemical and physical properties (tensile and yield) of the steel.

9-10.5 Steel Piling

The material for steel piling and pile splices shall conform to the requirements of the Specifications for Structural Steel, AASHTO M 183M, except the material for steel pipe piling, and splices shall conform to the requirements of ASTM A 252, grade 2. All steel piling may be accepted by the Engineer based on the Manufacturer's Certification of Compliance.

9-11 WATERPROOFING

9-11.1 Asphalt for Waterproofing

Asphalt for waterproofing shall conform to the requirements of ASTM D 312, Type 4.

The material used as primer shall conform to the requirements of ASTM D 41, Primer for Use with Asphalt in Dampproofing and Waterproofing.

Acceptance shall be as provided in Section 9-02.2(1).

9-11.2 Waterproofing Fabric

Waterproofing fabric shall be a saturated cotton fabric meeting the requirements of ASTM D 173, Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing.

9-11.3 Portland Cement Mortar

Portland cement and sand for the mortar protection course shall conform to the following requirements:

Portland Cement	Section 9-01
Sand	Section 9-03

9-12 MASONRY UNITS

9-12.1 Concrete Blocks

Concrete blocks for manholes and catch basins shall conform to the requirements of ASTM C 139.

Concrete blocks for building construction shall conform to the requirements of ASTM C 90.

9-12.2 Concrete Brick

Concrete brick shall conform to the requirements of ASTM C 55.

9-12.3 Vacant

9-12.4 Precast Concrete Manholes

Precast concrete manholes shall meet the requirements of AASHTO M 199M.

The joints may be of tongue and groove type or of the shiplap type, sufficiently deep to prevent lateral displacement.

As an alternate to steel reinforcement, 1200 millimeter diameter by 1 meter high eccentric or concentric cone sections may be reinforced with synthetic fiber. The synthetic fiber shall meet the requirements of ASTM C 116 Type III. The synthetic fiber shall be added at a rate of 0.45 kilograms per cubic meter of concrete and shall the thoroughly mixed with the concrete before placement in the forms. The synthetic fibers shall be a minimum of 19 millimeters and a maximum of 50 millimeters in length. A minimum of two hoops of W2 wire shall be placed in the 1200 millimeter end of each cone. No steel is required in the remainder of the cone. Precast concrete units shall be furnished with knockouts or cutouts.

9-12.5 Precast Concrete Catch Basins

Precast concrete catch basins shall conform to the requirements of Section 9-12.4, except that the dimensions shall be as set forth in the Standard Plan.

Knockouts or cutouts may be placed on all four sides and may be round or D shaped.

9-12.6 Precast Concrete Inlets

Precast concrete inlets shall conform to the requirements of Section 9-12.4 except that the dimensions shall be as set forth in the Standard Plan.

9-12.7 Precast Concrete Drywells

Precast concrete drywells shall meet the requirements of Section 9-12.4. Seepage port size and shape may vary per manufacturer. Each seepage port shall provide a minimum of 650 square millimeters and a maximum of 5625 square millimeters for round openings and 8400 square millimeters for rectangular openings. The ports shall be uniformity spaced with at least one port per 200 millimeters of drywell height and 380 millimeters of drywell circumstances.

9-13 RIPRAP, QUARRY SPALLS, SLOPE PROTECTION, AND ROCK WALLS

Riprap shall consist of broken stone, broken concrete rubble, or concrete in sacks. Quarry spalls shall consist of broken stone or broken concrete rubble. Riprap and quarry spalls consisting of broken stone or concrete rubble shall be free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather and shall conform to the following requirements for quality.

Degradation Factor	15 minimum
Los Angeles Wear, 500 Rev.	50% maximum
Specific Gravity	2.55 minimum

9-13.1 Loose Riprap

Loose riprap shall be free of rock fines, soil, or other extraneous material.

Should the riprap contain insufficient spalls, as defined in Section 9-13.6, the Contractor shall furnish and place supplementary spall material from a source approved by the Engineer, at the Contractor's expense.

The grading of the riprap shall be determined by the Engineer by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.

9-13.1(1) Heavy Loose Riprap

Heavy loose riprap shall meet the following requirements for grading:

	Minimum Size	Maximum Size
40% to 90%	1 tonne (1/2 m^3)	
70% to 90%	140 kg (0.06 m^3)	
10% to 30%	75 mm	25 kg (spalls)

9-13.1(2) Light Loose Riprap

Light loose riprap shall meet the following requirements for grading:

	Size Range	Maximum Size
20% to 90%	140 kg to 1 tonne (0.06 m^3 to 1/2 m^3)	
15% to 80%	25 kg to 1 tonne (0.1 m^3 to 1/2 m^3)	
10% to 20%	75 mm	25 kg (spalls)

9-13.2 Hand Placed Riprap

Hand placed riprap shall be as nearly rectangular as possible, 60 percent shall have a volume of not less than 0.03 cubic meter. No stone shall be used which is less than 150 millimeters thick, nor which does not extend through the wall.

9-13.3 Sack Riprap

Sack riprap shall consist of concrete placed in sacks made of at least 280-gram burlap and having a capacity of approximately 0.07 cubic meter. Each sack shall be filled with approximately 0.03 cubic meter of concrete having a consistency in conformance with Section 6-02.3(4)C for nonvibrated concrete.

Concrete for sack riprap exposed to fresh water and salt water shall be Class 20 as specified in Section 6-02.3.

The cement and fine and coarse aggregates shall conform to the requirements for cement and fine and coarse aggregate of Sections 9-01 and 9-03.1, respectively.

9-13.4 Vacant

9-13.5 Concrete Slope Protection

Concrete slope protection shall consist of reinforced Portland cement concrete poured or pneumatically placed upon the slope with a rustication joint pattern or semi-open concrete masonry units placed upon the slope closely adjoining each other.

9-13.5(1) Semi-Open Concrete Masonry Units Slope Protection

Precast cement concrete blocks shall conform to the requirements of ASTM C 90, Type II.

9-13.5(2) Poured Portland Cement Concrete Slope Protection

Cement concrete for poured concrete slope protection shall be Class 20 in conformance with Section 6-02.3.

Wire mesh reinforcement shall conform to the provisions of Section 9-07.7.

9-13.5(3) Pneumatically Placed Portland Cement Concrete Slope Protection

Cement: This material shall be Portland cement as specified in Section 9-01.

Aggregate: This material shall meet the requirements for fine aggregate as specified in Section 9-03.1. The moisture content of the fine aggregate at the time of use shall be between 3 percent and 6 percent by mass.

Reinforcement: Wire mesh reinforcement shall conform to the provisions of Section 9-07.7.

Water: Water shall conform to the provisions of Section 9-25.1.

9-13.6 Quarry Spalls

Quarry spalls shall meet the following requirements for grading:

Sieve Size	Percent Passing
200 mm	100
75 mm	40 max.
19 mm	10 max.

9-13.7 Rock for Rock Wall

9-13.7(1) Rock for Rock Walls and Chinking Material

Rock for rock walls and chinking material shall be hard, sound and durable material, free from seams, cracks, and other defects tending to destroy its resistance to weather, and shall meet the following minimum requirements:

Test	Test Method	Requirements
Specific Gravity	AASHTO T-85	2.55 min.
LA Wear	AASHTO T-96	50% max.
Degradation	WSDOT 113	15 min.
Absorption	AASHTO T-85	3% max.

Rock for rock wall sizes are approximately as follows:

Rock Size	Rock Mass (kg)	Average Dimension (m)
One Man	20 - 100	0.3 - 0.5
Two Man	100 -300	0.5 - 0.7
Three Man	300 - 900	0.7 - 0.9
Four Man	900 - 1800	0.9 - 1.2
Five Man	1800 - 2700	1.2 - 1.4
Six Man	2700 - 3600	1.4 - 1.5

Chinking material shall be a minimum of 100 millimeters average dimension.

9-13.7(2) Backfill for Rock Wall

Backfill for rock walls shall be shot rock ranging in size from a minimum of 50 mm to a maximum of 150 mm.

Acceptance shall be based on visual inspection by the Engineer.

9-14 EROSION CONTROL AND ROADSIDE PLANTING

9-14.1 Soil

9-14.1(1) Topsoil Type A

Topsoil Type A shall be as specified in the Special Provisions.

9-14.1(2) Topsoil Type B

Topsoil Type B shall be native topsoil taken from within the project limits either from the area where roadway excavation is to be performed or from strippings from borrow, pit, or quarry sites, or from other designated sources. The general limits of the material to be utilized for topsoil will be indicated in the Plans or in the Special Provisions. The Engineer will make the final determination of the areas where the most suitable material exists within these general limits. The Contractor shall reserve this material for the specified use. Material for Topsoil Type B shall not be taken from a depth greater than 300 millimeters from the existing ground unless otherwise designated by the Engineer.

In the production of Topsoil Type B, all vegetative matter, except large brush and trees over 1.2 meters in height, shall become a part of the topsoil. Prior to topsoil removal, the Contractor shall reduce the native vegetation to a height not exceeding 300 millimeters. Noxious weeds, as designated by authorized State and County officials, shall not be incorporated in the topsoil, and shall be removed and disposed of as designated elsewhere or as approved by the Engineer.

9-14.1(3) Topsoil Type C

Topsoil Type C shall be native topsoil meeting the requirements of Topsoil Type B but obtained from a source provided by the Contractor outside of the Contracting Agency owned right of way.

9-14.2 Seed

Grasses, legumes, or cover crop seed of the type specified shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification," latest edition. Seed shall be furnished in standard containers on which shall be shown the following information:

(1) Common name of seed,
(2) Lot number,
(3) Net mass,
(4) Percentage of purity,
(5) Percentage of germination (in case of legumes percentage of germination to include hard seed), and
(6) Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and Federal laws.

Upon request, the Contractor shall furnish to the Engineer duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within six months before the date of delivery on the project. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

9-14.3 Fertilizer

Fertilizer shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified. It may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid, and water-soluble potash in the amounts specified. All fertilizers shall be furnished in standard unopened containers with mass, name of plant nutrients, and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws.

Fertilizer shall be supplied in one of the following forms:

(1) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.
(2) A soluble form that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.
(3) A homogeneous pellet, suitable for application through a Ferti-blast gun.
(4) A tablet or other form of controlled release with a minimum of one-year release period.

9-14.3(1) Lime

Agriculture lime shall be of standard manufacture, flour grade, meeting the requirements of ASTM C-602.

9-14.4 Mulch and Amendments

9-14.4(1) Straw

All straw mulch material shall be in an air dried condition free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.

9-14.4(2) Wood Cellulose Fiber

Fiber shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials, or from newsprint, corrugated cardboard, or a combination of these processed materials. The fibers shall not contain any rock, metal, or plastic. It shall be treated with a nontoxic green dye to facilitate inspection of the placement of the material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture.

During the request for approval of the material source process, a letter of certification shall be submitted which certifies that the product contains less than 250 parts per million boron, and shall be otherwise nontoxic to plant or animal life. The organic matter content shall be at least 93 percent on an oven-dry basis as determined by ASTM D 586. The moisture content shall be no more than 15 percent as determined by oven dried mass.

Each package of the cellulose fiber shall be marked by the manufacturer to show the dried mass.

9-14.4(3) Bark or Wood Chips

Bark or wood chip mulch shall be derived from Douglas fir, pine, or hemlock species. It shall be ground so that a minimum of 95 percent of the material will pass through a 37.5-millimeter sieve and no more than 55 percent, by loose volume, will pass through a 6.3-millimeter sieve. The mulch shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life.

9-14.4(4) Sawdust

Sawdust mulch shall be free of chips, chunks, and large splinters, and shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life.

9-14.4(5) Vacant

9-14.4(6) Vermiculite/Perlite/Pumice

Vermiculite, perlite, or pumice shall be horticultural grade and free of any toxic materials.

9-14.4(7) Tackifier

Tackifier used as a tie-down for mulch shall conform to, and is specified as one of the following:

Type A — Organic tackifier shall be derived from natural organic plant sources containing no growth or germination inhibiting materials. It shall be applied in quantities sufficient to equal the retention properties of a CSS-1 asphalt emulsion being applied at the rate of 3740 liters per hectare. Tackifier shall hydrate in water and readily blend with other slurry materials. Wood cellulose fiber shall be added to the tackifier as a tracer at the rate of 168 kilograms per hectare. The tackifier shall be sprayed on the mulch after it is in place on the slopes.

Type B — Asphalt emulsion tackifier, a CSS-1 emulsion conforming to the requirements of Section 9-02.1(6).

9-14.4(8) Compost

Compost products shall contain composted plant material derived from the aerobic decomposition of recycled plant waste. The composted plant waste shall have a moisture content that has no visible free water or dust produced when handling the material.

9-14.4(9) Soil Amendments

All amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis and name. In lieu of containers, amendments may be furnished in bulk. A certificate from the manufacturer or supplier indicating the above information shall accompany each delivery. Compost and other organic amendments shall be accompanied with all applicable health certificates and permits.

9-14.5 Matting

9-14.5(1) Jute Matting

Jute matting shall be of a uniform open plain weave of unbleached, single jute yarn treated with a fire retardant chemical. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than 1/2 of its normal diameter. Jute matting shall

be furnished in rolled strips approximately 46 meters in length. Matting width shall be 1220 millimeters with an average mass of 0.5 killograms per square meter. A tolerance of plus or minus 25 millimeters in width and 5 percent in mass will be allowed.

9-14.5(2) Erosion Control Blanket

Erosion control blanket shall be a machine produced mat of wood excelsior covered on one side with a plastic netting or twisted paper composition.

The erosion control blanket shall have a minimum dry mass of wood fibers of 0.43 kilograms per square meter, plus or minus 5 percent. It shall be of uniform thickness, with the fiber evenly distributed over the entire area of the mat.

The plastic netting shall have a 76-millimeter by 76-millimeter maximum mesh size.

The width of matting and net shall be 900 millimeters, and the rolls shall be approximately 46 meters long.

9-14.5(3) Clear Plastic Covering

Clear plastic covering shall meet the requirements of the NBS Voluntary Product Standard, PS 17-69, for polyethylene sheeting having a minimum thickness of 150 micrometers.

9-14.6 Plant Materials

9-14.6(1) Description

Seedlings are plants grown from cuttings, seeds, or other approved propagation methods. These plant materials do not normally show form characteristic to species generally under three years of age and less than 600 millimeters in height. Measurement is by height in 75-millimeter increments or by age and number of times transplanted.

Whips are bareroot, broadleaf trees, generally unbranched and between 600 millimeters and 1.8 meters in height. Measurement is by 0.3-meter height increments.

Broadleaf trees are branched, over 1.8 meters in height and measured by caliper and/or height.

Coniferous trees are over 600 millimeters in height and measured in height and occasionally spread.

Shrubs and ground covers begin to show form characteristic to their normal habit of growth and are measured by height and/or spread.

Container sizes may be specified in addition to other measurements, however, the other measurements shall govern.

Cuttings are live plant material without a previously developed root system. Source plants for cuttings shall be dormant when cuttings are taken. All cuts shall be made with a sharp instrument. Written permission shall be obtained from property owners and provided to the Engineer before cuttings are collected. The Contractor shall collect cuttings in accordance with applicable sensitive area ordinances. For cuttings, the requirement to be nursery grown or held in nursery conditions does not apply. Cuttings include the following forms:

Live branch cuttings shall have flexible top growth with terminal buds and may have side branches. The rooting end shall be cut at an approximate 45 degree angle.

Live stake cuttings shall have a straight top cut immediately above a bud. The lower, rooting end shall be cut at an approximate 45-degree angle. Live stakes are cut from one to two year old wood.

Live pole cuttings shall have a minimum 50 mm diameter and no more than three branches which shall be pruned back to the first bud from the main stem.

9-14.6(2) Quality

All plant material furnished shall meet the grades established by the latest edition of the American Standard for Nursery Stock, shall conform to the size and acceptable conditions as listed in the contract, and shall be free of all foreign plant material.

All plant material shall comply with State and Federal laws with respect to inspection for plant diseases and insect infestation.

All plants shall consist of live woody or herbaceous plant material and shall be vigorous, well formed, with well developed fibrous root systems, free from dead branches, lichens, and from damage caused by an absence or an excess of heat or moisture, insects, disease, mechanical or other causes detrimental to good plant development. Evergreen plants shall be well foliated and of good color. Deciduous trees which have solitary leaders shall have only the lateral branches thinned by pruning.

All conifer trees shall have only one leader (growing apex) and one terminal bud, and shall not be sheared or shaped.

Trees having a damaged or missing leader, multiple leaders, or Y-crotches shall be rejected.

Root balls of plant materials shall be solidly held together by a fibrous root system and shall be composed only of the soil in which the plant has been actually growing. The ball shall be securely wrapped with jute burlap or other packing material not injurious to the plant life. Root balls shall be free of weed or foreign plant growth.

Plant materials shall be nursery grown stock. Plant material gathered from native stands shall be held under nursery conditions for a minimum of one full growing season, shall be free of all foreign plant material, and meet all of the requirements of these Specifications, the Plans, and the Special Provisions.

Container grown plants must be plants transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container. Plant material which is root bound, as determined by the Engineer, shall be rejected.

Container sizes for plant material of a larger grade than provided for in the container grown specifications of the American Standard for Nursery Stock (ASNS) shall be determined by the volume of the root ball specified in the ASNS for the same size plant material.

All bare root plant materials shall have a heavy fibrous root system. All plants must be dormant at the time of planting.

Average height to spread proportions and branching shall be in accordance with the applicable sections, illustrations, and accompanying notes of the American Standard for Nursery Stock.

Plants, which have been determined by the Engineer to have suffered damage as the result of girdling of the roots, stem, or a major branch; have deformities of the stem or major branches; have a lack of symmetry; have dead or defoliated tops or branches; or have any defect, injury, or condition which renders the plant unsuitable for its intended use, shall be rejected.

Plants that are grafted shall have roots of the same genus as the specified plant.

9-14.6(3) Handling and Shipping

Handling and shipping shall be done in a manner that is not detrimental to the plants.

The nursery shall furnish a notice of shipment in triplicate at the time of shipment of each car load or other lot of plant material. The original copy shall be mailed to the Project Engineer, the duplicate to the consignee and the triplicate shall accompany the shipment to be furnished to the Inspector at the job site. The notice shall contain the following information:

1. Name of shipper.
2. Date of shipment.
3. Name of commodity. (Including all names as specified in the contract.)
4. Consignee and delivery point.
5. State contract number.
6. Point from which shipped.
7. Quantity contained.
8. Certificate of Grade. (Statement that material conforms to the specifications.)
9. Size. (Height, runner length, caliper, etc. as required.)
10. Statement of root pruning. (Date pruned and size of pruning.)
11. Signature of shipper by authorized representative.

To acclimate plant materials to Northwest conditions, all plant materials used on a project shall be grown continuously outdoors north of the 42nd Latitude (Oregon-California border) from not later than August 1 of the year prior to the time of planting.

All container grown plants shall be handled by the container.

All balled and burlapped plants shall be handled by the ball.

Plant material shall be packed for shipment in accordance with prevailing practice for the type of plant being shipped, and shall be protected at all times against drying, sun, wind, heat, freezing, and similar detrimental conditions both during shipment and during related handling. Where necessary, plant material shall be temporarily heeled in. When transported in closed vehicles, plants shall receive adequate ventilation to prevent sweating. When transported in open vehicles, plants shall be protected by tarpaulins or other suitable cover material. Antidesiccant material shall be applied before shipment.

9-14.6(4) Tagging

Plants delivered as a single unit of 25 or less of the same size, species, and variety, shall be clearly marked and tagged. Plants delivered in large quantities of more than 25 must be segregated as to variety, grade, and size; and one plant in each 25, or fraction thereof, of each variety, grade, and size shall be tagged.

9-14.6(5) Inspection

The Contracting Agency will make no inspection of plant material at the source except as it may elect. Control samples of plant material may be submitted to the Engineer for approval as to size, grade, variety, etc.; however, such approval shall not be considered as final acceptance for payment. The Contractor shall notify the Engineer, not less than 48 hours in advance, of plant material delivery to the project.

9-14.6(6) Substitution of Plants

No substitution of plant material, species or variety, will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the award of the contract. If substitution is permitted, it can be made only with written approval by the Engineer. The nearest variety, size, and grade, as approved by the Engineer, shall then be furnished.

Container or balled and burlapped plant material may be substituted for bare root plant material. Container grown plant material may be substituted for balled and burlapped plant materials. Container size shall be determined by the volume of the root ball that is specified. These substitutions shall be approved by the Engineer and be at no cost to the Contracting Agency.

9-14.6(7) Temporary Storage

Plants stored under temporary conditions shall be the responsibility of the Contractor.

Plants stored on the project shall be protected at all times from extreme weather conditions by insulating the root balls with sawdust, soil, or other approved material and shall be kept moist at all times.

Cuttings to be stored for periods longer than one week shall be taken during the months of November and December. Cuttings to be stored for later installation shall be bundled, laid horizontally, and completely buried under 150 mm of soil or placed in cold storage in plastic bags at a temperature range of 1°C to 5°C.

9-14.6(8) Sod

The available grass mixtures on the current market shall be submitted to the Engineer for selection and approval.

The sod shall be field grown one calendar year or older, have a well developed root structure, and be free of all weeds, disease, and insect damage.

Prior to cutting, the sod shall be green, in an active and vigorous state of growth, and mowed to a height not exceeding 25 millimeters.

The sod shall be cut with a minimum of 25 millimeters of soil adhering.

9-14.7 Stakes, Guys, and Wrapping

Stakes shall be wood and shall be installed as shown in the Plans.

The minimum size of wire used for guying shall be 14 gage, soft drawn. Commercial plant ties may be used in lieu of hose and wire guying upon approval of the Engineer.

Hose for guying shall be nylon, rubber, or reinforced plastic and shall have an inside diameter of at least 13 millimeters.

Tree wrap shall be a crinkled waterproof paper weighing not less than 0.19 kilograms per square meter and shall be made up of two sheets cemented together with asphalt.

9-15 IRRIGATION SYSTEM

All materials and equipment incorporated in the system shall be new, undamaged, of standard quality, and shall be subject to testing as specified.

9-15.1 Pipe, Tubing, and Fittings

Pipe shall be galvanized iron, PVC, or polyethylene, as specified in the Plans or in the Special Provisions.

9-15.1(1) Galvanized Pipe and Fittings

Pipe shall be standard mass, hot-dip galvanized iron or steel pipe, threaded and coupled. Pipe shall meet the requirements of ASTM A 53.

All pipe fittings shall be standard threaded galvanized malleable iron fittings.

9-15.1(2) Polyvinyl Chloride Pipe and Fittings

PVC pipe and fittings, where indicated in the Plans, shall be of PVC compound Type 1, Grade 1, conforming to ASTM D 1784 specifications. The pipe and fittings shall be approved and certified by the National Sanitation Foundation. Pipe and fittings shall be free from defects in materials, workmanship, and handling. The Engineer may require dimensional and quick burst tests of pipe and fittings after arrival at the job site. Acceptance of the materials shall be subject to passing the designated tests per ASTM Standards.

PVC solvent weld pipe shall be of PVC 1120 material and shall have 1380 kilopascals minimum pressure rating with SDR 21 walls which conform to ASTM D 2241. PVC pipe with walls heavier than SDR 21 shall be installed when noted in the Plans and specified in the Special Provisions. PVC threaded pipe shall be of PVC 1120 material and shall be schedule 80 which conforms to ASTM D 1785.

PVC pipe fittings shall conform to ASTM D 2466, Type I, Grades 1 or 2. Pipe may be belled on one end with the dimensions of the tapered bell conforming to ASTM D 2672.

Each length of PVC pipe is to be marked with an identifying extrusion “run” number and the manufacturer’s name or trade name plus the pipe size and schedule.

9-15.1(3) Polyethylene Pipe

Polyethylene pipe shall be Class 80, SDR 15, medium density polyethylene pipe, meet the requirements of ASTM D 2239, conform to U.S. Commercial Standard CS-255, and be National Sanitation Foundation (NSF) approved.

Thick walled polyethylene (poly) pipe shall be used in conjunction with fittings recommended by the manufacturer of the poly pipe to produce a flexible swing joint assembly between the lateral line and the irrigation head. The pipe shall be manufactured from high quality, low density virgin polyethylene material and have a minimum wall thickness of 2.54 millimeters and a minimum inside diameter of 12.45 millimeters. The pipe shall be capable of withstanding 550 kilopasals operating water pressure at 43°C. The length of thick walled poly pipe at each flexible swing joint assembly shall be 450 millimeters minimum to 900 millimeters maximum.

9-15.2 Drip Tubing

Drip tubing shall be manufactured from specially formulated, chemical resistant, low to medium density virgin polyethylene or polybutylene selected for excellent weatherability and stress cracking resistance and designed specifically for use in drip irrigation systems. Drip tubing shall have a minimum wall thickness of 1.14 millimeters and shall have a written warranty from the manufacturer against defects in manufacturing, rot,

electrolytic corrosion, or stress cracking for a period of five years minimum from the time of installation. Quality of drip tubing shall be as manufactured by Spot System, Pepco, Reed, Agrifim, or approved equal.

9-15.3 Automatic Controllers

Automatic controllers shall be installed on a concrete base. They shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operator. Controllers shall be enclosed in a weatherproof, painted, metal housing fabricated from 16 gage sheet aluminum alloy 6061-T6, or from 16 gage sheet steel metal.

A pedestal or skirting shall be placed around the conduit leading to the metal housing shown in the Plans. It shall be of the same material and finish as the housing. The Contractor shall submit a plan of the proposed design for the pedestal or skirting to the Engineer for approval before fabrication. Controller housing shall have hasp and lock or locking device. All locks or locking devices shall be master keyed and three sets of keys provided. The controller shall be compatible with and capable of operating the irrigation system as designed and constructed and shall include the following operating features:

1. Each controller station shall be adjustable for setting to remain open for any desired period of time — from five minutes or less to at least one hour.
2. Adjustments shall be provided whereby any number of days may be omitted and whereby any one or more positions on the controller can be skipped. When adjustments are made, they shall continue automatically within a 14-day cycle until the operator desires to make new adjustments.
3. Controls shall allow any position to be operated manually both on or off whenever desired.
4. Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.
5. Controllers shall contain an on-off switch and fuse assembly.

9-15.4 Sprinkler Heads

Sprinkler heads shall be of the type, pattern, and coverage shown in the Plans at rated operating pressure specified, discharging not more than the amount of liters per minute listed.

Sprinkler heads shall be designed so that spray adjustments can be made by either an adjustment screw or interchangeable nozzles. Watering cores shall be easily removed without removing the housing from the pipe.

9-15.5 Valve Boxes and Protective Sleeves

All automatic control valves, flow control valves, and pressure reducing valves shall be provided with valve boxes. Valve boxes shall conform to the Plans and shall be extendible to obtain the depth required. All manual drain valves and manual control valves shall be equipped with a protective sleeve and cap as shown in the Plans.

9-15.6 Gate Valves

Gate valves when called for in the Plans shall be heavy duty bronze conforming to the requirements of ASTM B 62. Valves shall be of the same size as the pipes on which they are placed and shall have union or flange connections. Service rating (for nonshock cold

water) shall be 1035 kilopascals. Valves shall be of the double disk, taper seat type, with rising stem, union bonnet and hand wheel or suitable cross wheel for standard key operation. Manufacturer's name, type of valve, and size shall be cast on the valve.

9-15.7 Control Valves

9-15.7(1) Manual Control Valves

Manual valves shall be bronze or brass, angle type with hex brass union. Service rating shall be not less than 1035 kilopascals nonshock cold water. Valves shall be designed for underground installation with suitable cross wheel for operation with a standard key. The Contractor shall furnish three suitable operating keys per contract. Valves shall have removable bonnet and stem assembly with adjustable packing gland and shall house long acme threaded stem to ensure full opening and closing. Valve discs shall be full floating with replaceable seat washers.

9-15.7(2) Automatic Control Valves

Automatic remote control valves shall be globe pattern with flanged or screwed connections as required. The valve shall be constructed so as to allow all internal parts to be removable from the top of the valve without disturbing the valve installation.

Valves shall be of a normally closed design and shall be electric solenoid operated, having maximum rating of 6.5 watts utilizing 24 volt AC power. Solenoids shall be directly attached to the valve bonnets or body with all control parts completely internal. Valves shall be of 1035 kilopascals brass or bronze, or iron body bronze-mounted combination. The opening and closing speed of the valve shall be a minimum of five seconds for closure and a minimum of three seconds for opening with a constant rate of opening and closing. A manual control bleed cock shall be included on the valve to operate the valve without the requirement of electric current. A manual shutoff stem with cross handle for wrench operation is required for manual adjustment from fully closed to wide open. Once the manual adjustment is set, the valve shall operate automatically in the adjusted position. Water flow shall be completely stopped when the control valve is closed either manually or automatically. Automatic control valves and automatic controllers need not be from the same manufacturer.

9-15.7(3) Automatic Control Valves With Pressure Regulator

The automatic control valve with pressure regulator shall be similar to the automatic control valve and shall also reduce the inlet pressure to a constant lower pressure regardless of supply fluctuations. The regulator must be fully adjustable.

9-15.8 Quick Coupling Equipment

Quick coupler valves shall have a service rating not less than 860 kilopascals for nonshock cold water. The body of the valves shall be of cast leaded semi-red brass alloy No. C84400 conforming to ASTM B 584. The base of the valve shall have standard female pipe threads. The design of the valve shall be such that it will open only upon inserting a coupler key and will close as the coupler is removed from the valve. Leakage of water between the coupler and valve body when in operation will not be accepted. The valve body receiving the coupler shall be designed with double worm slots to allow smooth action in opening and closing of the valve with a minimum of effort. Slots shall be notched at the base to hold the coupler firmly in the open position. Couplers shall be of the same material as the valve body with stainless steel double guide lugs to fit the worm slots. Couplers shall

be of one piece construction with steel reinforced side handles attached. All couplers shall have standard male pipe threads at the top. Couplers shall be furnished with all quick coupler valves unless otherwise specified.

9-15.9 Drain Valves

Drain valves shall be 13 or 19 millimeters in size and shall be of bronze or brass, manual angle globe type, with rising stem, hex brass union, removable bonnet and stem, and adjustable packing gland. Valves shall be designed for underground installation with suitable cross wheel for operation with a standard key, and shall have a service rating of not less than 1035 kilopascals nonshock cold water. The Contractor shall furnish three standard operating keys per contract.

On potable systems, drain valves shall be allowed only in the downstream side of approved cross-connection control devices.

9-15.10 Hose Bibs

Hose bibs shall be constructed of bronze or brass, angle type threaded to accommodate a 19-millimeter hose connection, and shall be key operated. Design shall be such as to prevent operation by wrench or pliers.

9-15.11 Cross-Connection Control Devices

Atmospheric vacuum breaker assemblies (AVBAs), pressure vacuum breaker assemblies (PVBAs), double check valve assemblies (DCVAs), and reduced pressure backflow devices (RPBDs), shall be of a type approved by the Washington State Department of Health, Olympia, Washington.

9-15.12 Check Valves

Adjustable spring check valves shall be PVC and shall be pressure rated at 1380 kilopascals. Valves shall be adjustable from 22- to 67-newton spring tension, but shall not cause pressure loss in excess of 35 kilopascals for flows up to 115 liters per minute. Valves shall have angled seats, Buna-N seals and threaded connections, and shall be installed in 150-millimeter Schedule 40 PVC sleeves with removable caps or 150-millimeter round plastic valve boxes.

9-15.13 Pressure Regulating Valves

Pressure regulating valves shall have a minimum of 1035 kilopascals working pressure with an adjustable outlet range of 140 to 480 kilopascals. The valves shall be factory set as shown in the Plans. Pressure regulating valves shall be rated for safe operation at 1200 kilopascals nonshock cold water.

9-15.14 Three-Way Valves

Three-way valves shall be tight closing, three port, ball or plug type, constructed to permit straight through and 90 degree flow only. The valve shall be of bronze or approved corrosion resistant body materials and shall have a minimum of 1035 kilopascals working pressure. The head of the valve, or handle when applicable, shall be permanently marked to indicate port position. Whenever handles are included as an integral part of the valve, the Contractor shall remove the handles and give them to the Engineer for ultimate distribution to the Maintenance Division.

9-15.15 Flow Control Valves

Valve body materials shall be plastic or metal. Internal parts shall be stainless steel. Valves shall be factory set to plan flows. Valves shall have no external adjustment and be tamper proof when installed. Eight millimeter and smaller flow control valves shall have a minimum pressure absorption range of 14 to 220 kilopascals. Thirty-eight millimeter and larger flow control valves shall have a minimum pressure absorption range of 20 to 345 kilopascals.

Flow shall be controlled to 5 percent of plan volumes.

9-15.16 Air Relief Valve

The air relief valve shall automatically relieve air and break a vacuum in the serviced pipe. Body materials shall be installed exactly at all high points.

9-15.17 Electrical Wire and Splices

Electrical wire used in the irrigation system shall comply with Section 9-29.3. Electrical wire used between the automatic controller and automatic valves shall be copper AWG No. 14 minimum size, Type USE Chemically Cross Linked Polyethylene or Thermoplastic, Type UF, and shall be color coded or marked with number identification.

Low voltage splices shall be made with a kit containing a “T” shaped open cell centering device and a plastic bag of urethane and hardener which is mixed at the time of installation or heat shrinkable insulating tubing. Heat shrinking insulating tubing shall consist of a mastic lined heavy wall polyolefin cable sleeve. The resin used with the “T” shaped open cell centering device shall be a quick curing flexible compound with an approximate set-up time of 4 minutes at 22°C.

9-15.18 Detectable Marking Tape

Detectable marking tape shall consist of inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil, with a metallic foil core to provide the most positive detection and pipeline locators.

The tape shall be color coded and shall be imprinted continuously over its entire length in permanent black ink. The message shall convey the type of line buried below and shall also have the word “Caution” prominently shown. Color coding of the tape shall be as follows:

Utility	Tape Color
Water	Blue
Sewer	Green
Electrical	Red
Gas-Oil	Yellow
Telephone-CATV	Orange

The width of the tape shall be as recommended by the manufacture for the depth of installation.

9-15.19 Wye Strainers

Wye strainers shall be bronze or brass with screwed end connections, 850-micrometer Monel or stainless steel screen, and standard tapped bronze retainer cap and closure plug. Service rating shall be not less than 1035 kilopascals nonshock cold water.

9-16 FENCE AND GUARDRAIL

9-16.1 Chain Link Fence and Gates

9-16.1(1) General

All material used in the construction of chain link fence and gates shall be new. Iron or steel material shall be galvanized unless specified otherwise. Imperfectly galvanized material or material upon which serious abrasions of galvanizing occur will not be acceptable.

9-16.1(1)A Class 1 Material

Class 1 material may be used for chain link fence construction statewide.

The base material for the manufacture of steel pipes used for posts, braces, top rails, and gate frames shall conform to the requirements of ASTM F 1083. The base material for the manufacture of steel H columns shall meet the requirements of ASTM A 663M.

Roll-formed posts, braces, and rails shall be made from sheet steel and shall conform with the details as shown in the Plans or Standard Plans. The material for end, corner, and pull posts shall have a minimum yield strength of 240 megapascals. The minimum yield strength for Alternate A roll-formed line posts shall be 275 megapascals and for Alternate B roll-formed line posts 310 megapascals. Top rail and braces to be used with Alternate A or B line posts shall conform to the minimum yield strength as required for either post respectively.

All posts, braces, top rails, and gate frames shall be hot-dip galvanized. They shall have a minimum average of 550 grams zinc coating per square meter of surface area with no individual test being below 490 grams zinc coating per square meter of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average mass of coating is defined as a 300-millimeter piece cut from each end of the galvanized member. Fittings shall be galvanized in accordance with the requirements of ASTM F 626. Other materials shall be galvanized in accordance with the requirements of ASTM A 153.

9-16.1(1)B Class 2 Material

Class 2 material may be used for chain link fence posts for construction east of the Cascades only.

Class 2 pipe shall meet the outside dimensions of ASTM A 53, Schedule 40 and have a minimum yield strength of 345 magapascals. Class 2 pipe shall be hot-dip zinc coated with 275 grams per square meter of exterior surface and shall be over coated with clear acrylic. The internal surface of pipe shall have a protective coating of hot-dip zinc or zinc rich paint with a minimum thickness of 8 micrometers.

9-16.1(2) Posts

9-16.1(2)A Roll-Formed Posts

Roll-formed posts for chain link fence shall be of Class 1 material and be the shape, size, and mass per meter shown in the Standard Plans. Roll-formed end, corner, and pull posts shall be made from 3.45-millimeter minimum thickness sheet steel and shall have integral fastening loops to connect to the fabric for the full length of each post. Roll-formed line posts shall be made from 2.8-millimeter minimum thickness sheet steel for Type 3 and Type 4 fences and shall be made from 3-millimeter minimum thickness sheet steel for Type 1 and Type 6 fences.

9-16.1(2)B Pipe Posts, Class 1

Class 1 pipe sections shall conform to ASTM A 53, Schedule 40, Standard Weights.

An acceptance tolerance for posts for chain link fence will allow deviation from the mass per meter specified in the Standard Plans. This tolerance shall be applied on an individual post basis and shall be plus or minus 5 percent for tubular and H-Section posts and plus or minus 6 percent for roll form sections. Materials that exceed the mass per meter or wall thickness specification may be accepted, providing they do not interfere with the proper construction of the fence.

9-16.1(2)C Pipe Posts, Class 2

Class 2 posts shall be produced by a facility under program quality control. A manufacturer's Certificate of Compliance reflecting the Quality Control Program, shall be the sole basis of acceptance. Uncertified materials must be tested prior to use and shall conform to Class 1.

9-16.1(3) Top Rail, Braces, and Trusses

Top rail and compression braces shall be of the type and size shown in the Standard Plans. Tension truss rods shall be 10-millimeter round galvanized rods with drop forged turnbuckles, or other approved type of adjustment. Couplings for tubular sections shall be outside sleeve type and at least 150 millimeters long. Roll-formed top and brace rails shall be made from 1.9-millimeter thick sheet steel and shall be an open rectangular section with internal flanges. The acceptable thickness tolerance for sheet steel members shall be plus or minus 0.15 millimeter.

9-16.1(4) Tension Wire and Attachments

Top and bottom wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 245 grams per square meter of surface area. All tension wire attachments shall be hot-dip galvanized steel unless otherwise specified. Eye bolts shall be 10-millimeter diameter and of sufficient length to fasten to the type of posts used.

9-16.1(5) Vacant

9-16.1(6) Fittings

All fittings and miscellaneous hardware shall be malleable cast iron or pressed steel. Fittings shall be galvanized in accordance with ASTM F 626. Galvanizing of miscellaneous hardware not covered by ASTM F 626 shall be in conformance with ASTM A 153. Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

9-16.1(7) Chain Link Fence Fabric

Chain link fabric shall consist of 11 gage wire (3-millimeter diameter) for Types 3, 4, and 6 fence; and 9 gage wire (3.75-millimeter diameter) for Type 1 fence. The fabric wire may be one of the following materials provided that only one type shall be selected for use in any one contract:

Galvanized steel wire conforming to ASTM A 392.

Galvanizing shall be Class I performed by the hot-dip process.

Aluminum coated steel wire conforming to ASTM A 491.

Class II aluminum wire conforming to 6061-T94 alloy.

The wire shall be woven into approximately 50-millimeter diamond mesh. The width and top and bottom finish of the fabric shall be as shown in the Plans.

9-16.1(8) Fabric Bands and Stretcher Bars

Fabric bands shall be 3 millimeter by 25 millimeter nominal and stretcher bars 5 millimeter by 19 millimeter nominal. Nominal shall be construed to be the area of the cross-section of the shape obtained by multiplying the specified width by thickness. A variation of plus or minus 5 percent from this theoretical area shall be construed as "nominal" size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626M.

9-16.1(9) Tie Wire

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211M or 9 gage galvanized wire meeting the requirements of AASHTO M 279M. Galvanizing shall be Class 1. Hog rings shall meet the requirements of AASHTO M 279M. Galvanizing shall be Class 1.

9-16.1(10) Chain Link Gates

Gate frames shall be constructed of not less than 38-millimeter inside diameter hot-dip galvanized pipe with nominal mass of 4 kilograms per meter. The corners of the gate frame shall be fastened together and reinforced with a malleable iron or pressed steel fitting designed for the purpose, or they may be welded. Welding shall conform to the requirements of Section 6-03.3(25). All welds shall be ground smooth and painted with a high zinc dust content paint meeting the requirements of MIL-P-21035. The paint shall be applied in one or more coats to provide a dry film thickness of 90 micrometers minimum.

Cross trussing shall be 10-millimeter galvanized steel adjustable rods.

Chain link fence fabric for filling the gate frame shall meet the fabric requirement specified for chain link fence of the type being furnished.

Each gate shall be furnished complete with necessary hinges, latch, and drop bar locking device designed for the type of gate posts and gate used on the project. Gates shall have positive type latching devices with provisions for padlocking.

Gate frames constructed of steel sections, other than pipe, that are fabricated in such a manner as to form a gate of equal or better rigidity may be used provided they are approved by the Engineer.

9-16.1(11) Miscellaneous

All concrete shall be Class 20 as specified in Section 6-02.3.

9-16.2 Wire Fence and Gates

9-16.2(1) General

All materials used in the construction of the wire fence shall be new. All iron or steel material shall be galvanized. Imperfectly galvanized material or material upon which serious abrasions of galvanizing occur shall not be used.

9-16.2(2) Steel Fence Posts and Braces

Steel fence posts and braces shall be of good commercial quality iron or steel and shall be approved by the Engineer prior to construction. Posts shall be not less than 2.1 meters in length.

Line posts may be channel, T, U, Y, or other approved shape, manufactured solely for use as fence posts. One type of line post shall be used throughout the project. Line posts shall be studded, slotted, or properly adapted for attaching either wire or mesh in a manner that will not damage the galvanizing of posts, wire, or mesh during the fastening. Line posts

shall have a minimum mass of 1.98 kilograms per meter and shall be provided with a tapered steel anchor plate attached securely having a minimum mass of 0.30 kilograms and having a surface area of 12 900 square millimeters plus or minus 1300 square millimeters.

End, corner, gate, and pull posts shall meet the requirements specified for line posts, except that the posts shall have a minimum mass of 4.61 kilograms per meter and anchor plates and special studs, slots, or adapters for the attachment of wires will not be required.

Braces shall have a minimum mass of 4.61 kilograms per meter.

All posts, braces, anchor plates, and hardware not covered by ASTM F 626 shall be galvanized in accordance with the requirements of ASTM A 123, or A 153.

A tolerance of minus 5 percent on the mass of individual posts, braces, or anchor plates will be permitted.

9-16.2(3) Wood Fence Posts and Braces

Douglas fir, Western red cedar, hemlock, or larch shall be used in the construction of wood fence posts and braces. The material shall be of good quality and approved by the Engineer before use. Peeler cores shall not be used for round posts. Wood fencing materials shall have sufficient sapwood in the outer periphery to obtain the specified penetration of preservative. Fencing materials shall be cut to the correct length before pressure treatment.

Line posts shall be 75-millimeter minimum diameter round posts or nominal 75-millimeter by 75-millimeter square sawed posts. If the posts are to be pointed for driving, they shall be pointed before treatment. Line posts shall be at least 2.1 meters in length.

Pull posts and brace posts shall be 150-millimeter diameter round posts or nominal 140-millimeter by 140-millimeter material not less than 2.1 meters in length.

End, gate, and corner posts, and posts at an intersecting fence shall be 150-millimeter diameter round posts or nominal 140-millimeter by 140-millimeter material not less than 2.4 meters in length.

All sawed posts and timbers shall meet the requirements in the table under Section 9-09.2.

The preservatives used to pressure-treat wood fencing materials shall meet the requirements of Section 9-09.3.

The retention and penetration of the preservative shall be as follows:

Preservative	Minimum Retention in Kilograms Per Cubic Meter Sawed Posts	Minimum Penetration
Creosote	128.15	10 mm or 90% of sapwood impregnated
Pentachlorophenol	6.41	
CCA, ACA, or ACZA	6.41	
	Sawed Posts	
Creosote	96.11	75% of sapwood impregnated
Pentachlorophenol	4.81	
CCA, ACA, or ACZA	4.81	

9-16.2(4) Brace Wire

Brace wire shall be 9 gage galvanized wire meeting the requirements of ASTM A 116, galvanizing Class 2.

9-16.2(5) Staples and Wire Clamps

The staples used to attach the wire fencing to wood posts shall be galvanized 9 gage, 38 millimeters long meeting the requirements of AASHTO M 279, galvanizing Class 1.

The wire clamps used to attach the wire fencing to steel posts shall be galvanized 11 gage wire meeting the requirements of AASHTO M 279, galvanizing Class 1.

9-16.2(6) Barbed Wire

Barbed wire shall conform to the requirements of AASHTO M 280, and shall consist of two strands of $12^1/_2$ gage wire, twisted with four point 14 gage barbs with the barbs spaced an average of 125 millimeters apart. Galvanizing shall be Class 2 or 3.

9-16.2(7) Wire Mesh

Wire mesh shall conform to the requirements of AASHTO M 279, and shall consist of eight horizontal wires with vertical stays spaced 150 millimeters apart. The top and bottom wires shall be 10 gage, and the intermediate wires and vertical stays shall be $12^1/_2$ gage. The mesh shall have a total width of 810 millimeters (Design No. 832-6-12-1/2). Galvanizing shall be Class 3. The zinc-coated wire as represented by the test specimens shall be capable of being wrapped in a close helix at a rate not exceeding 15 turns/minute around a cylindrical steel mandrel having a diameter the same as the specimen being tested, without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare fingers.

9-16.2(8) Vertical Cinch Stays

Vertical cinch stays shall be $9^1/_2$ gage galvanized wire meeting the requirements of AASHTO M 279, except that the minimum mass of zinc coating shall be 92 grams per square meter of uncoated wire surface.

9-16.2(9) Wire Gates

Gate frames shall be constructed of galvanized standard pipe with a nominal diameter of not less than 25 millimeters. The pipe shall conform to the requirements of ASTM A 53. Wire gates shall be not less than 1219 millimeters in height and shall be designed to fit openings of the widths called for in the Plans or as indicated by the bid items. Each gate shall be provided with two upright braces of the same material as the frame, spaced at $^1/_3$ points in the gate. All gates shall be provided with adjustable 10-millimeter diameter diagonal truss rods from corner to corner.

The gate frame shall be provided with wire mesh conforming to the requirements specified in Section 9-16.2(7), except that it shall consist of 10 horizontal wires and have a total width of 1193 millimeters.

Each gate shall be furnished complete with necessary hinges and latch designed for use with the type of gate posts used on the project. The hinges shall be so designed as to be securely attached to the gate post and to enable the gate to be swung back against the fence.

Double gates shall be hinged in the same manner as single gates and shall be provided with an approved drop bar locking device.

9-16.2(10) Miscellaneous

Bolts, nuts, and hinges used in the construction of fence and gates shall be galvanized in accordance with AASHTO M 232.

All concrete shall be Class 20 as specified in Section 6-02.3.

9-16.3 Beam Guardrail

9-16.3(1) Rail Element

The W-beam or thrie beam rail elements, backup plates, reducer sections and end sections conform to "A Guide to Standardized Highway Barrier Hardware" published by AASHTO, AGC, and ARTBA. All rail elements shall be formed from 12 gage steel except for thrie beam used for bridge rail retrofit and Design F end sections, which shall be formed from 10 gage steel.

The rail splices shall have a minimum total ultimate strength of 355 kilonewtons at each joint.

The 150-millimeter channel rails and splice plates shall be in conformance with AASHTO M 183M. All fabrication shall be complete before galvanizing.

The holes in the plate shall be slotted to facilitate erection and to permit expansion and contraction. The edges of the rail shall be rolled or rounded so they will present no sharp edges. Where the rail is on a curve, the plates at the splice shall make contact throughout the area of splice. When the radius of curvature is less than 45 meters, the rail shall be shaped in the shop.

9-16.3(2) Posts and Blocks

Posts and blocks may be of creosote treated timber, pentachlorophenol treated timber, waterborne chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), ammoniacal copper zinc arsenate (ACZA), treated timber or galvanized steel; except only treated timber posts and blocks may be used for weathering steel beam guardrail. Blocks listed on the Qualified Products List that are made from alternate materials may be used in accordance with manufacturer's recommendations. Except for terminal or anchor assemblies, all posts for any one project shall be of the same type (wood or steel). Posts and blocks shall be of the size and length shown in the Plans and meet the requirements of these Specifications. Posts and blocks may be S4S or rough sawn.

Timber posts and blocks shall conform to the grade specified in Section 9-09.2, except pine lumber No. 1 grade may be used for the blocks. Timber posts and blocks shall be fabricated as specified in the Plans before being treated. Timber posts and blocks shall be treated by the empty cell process to provide a minimum retention, depending on the treatment used, according to the following:

Creosote oil	120 kg per m^3 of lumber
Pentachlorophenol	6.4 kg per m^3 of lumber
CCA	6.4 kg per m^3 of lumber
ACA	6.4 kg per m^3 of lumber
ACZA	6.4 kg per m^3 of lumber

Treatment shall be in accordance with Section 9-09.3.

Steel posts, blocks, and base plates, where used, shall conform to AASHTO M 183M, and shall be galvanized in accordance with AASHTO M 111. Welding shall conform to Section 6-03.3(25). All fabrication shall be completed prior to galvanizing.

9-16.3(3) Galvanizing

Beam rail elements and terminal sections shall be galvanized in accordance with AASHTO M-180, Class A, Type 2, except that the rail shall be galvanized after fabrication, with fabrication to include forming, cutting, shearing, punching, drilling, bending, weld-

ing, and riveting. In addition, the minimum average mass of zinc coating shall be 610 grams per square meter of surface (not sheet), the average to be determined on the basis of three individual tests, no one of which may be less than 550 grams per square meter of surface (not sheet). The aluminum content of the zinc bath during actual galvanizing operations shall not exceed 0.01 percent. Channel rails, splice plates, WF steel posts, and base plates shall be galvanized in accordance with ASTM A 123. Anchor cables shall be galvanized in accordance with Federal Specification RR-W-410, Table II, galvanized at finished size. Bolts, nuts, washers, plates, rods, and other hardware shall be galvanized in accordance with ASTM A 153.

9-16.3(4) Hardware

Bolts, unless otherwise specified, shall comply with ASTM A 307 Grade A specifications. High strength bolts shall conform to the requirements of AASHTO M 164M. Nuts shall comply with ASTM A 563M Grade A specifications. Washers, unless otherwise specified, shall meet ASTM F 844 specifications. The Contractor shall submit a manufacturer's certificate of compliance for the bolts, nuts, and washers prior to installing any of the hardware.

9-16.3(5) Anchors

Welding shall conform to Section 6-03.3(25).

All welding shall be equal in strength to the parent metal.

All fabrication shall be complete and ready for assembly before galvanizing. No punching, drilling, cutting, or welding will be permitted after galvanizing unless authorized by the Engineer.

Foundation tubes shall be fabricated from steel conforming to the requirements of ASTM A 500, grade B or ASTM A 501.

The anchor plate assembly shall develop a minimum tensile strength of 178 kilonewtons.

The anchor plate, W200 × 27 and metal plates shall be fabricated of steel conforming to the specifications of ASTM A 36.

Anchor cable shall be 19-millimeter preformed, 6 × 19 wire strand core or independent wire rope core (IWRC), galvanized, right regular lay manufactured of improved plow steel with a minimum breaking strength of 190 kilonewtons. Two certified copies of mill test reports of the cable used shall be furnished to the Engineer.

Swaged cable fittings shall develop 100 percent of the specified breaking strength of the cable. One swaged fitting attached to 1 meter of cable shall be furnished to the Engineer for testing.

The swaged fitting and stud assembly shall be of steel conforming to the requirements of American Iron and Steel Institute C-1035 and shall be annealed and galvanized suitable for cold swaging.

All metal components of the anchor and cable assembly and not less than the top 350 millimeters of the W200 × 27 for the Type 2 anchor shall be hot-dip galvanized in accordance with Section 9-16.3(3).

Cement concrete, of the class specified, shall conform to the applicable requirements of Section 6-02.3.

Cement grout shall consist of one part Portland cement and two parts sand.

9-16.3(6) Inspection and Acceptance

The Contractor shall give notice to the Engineer before the rail elements are fabricated in order that inspections may be provided. The Contractor shall arrange for all facilities necessary for the inspection of material and workmanship at the point of fabrication of the rail element, and inspectors shall be allowed free access to necessary parts of the premises.

The Inspector shall have the authority to reject materials or workmanship which do not fulfill the requirements of these Specifications. In cases of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

The Inspector may accept a mill test report certifying that the steel used in fabricating the rail element meets the requirements of the specifications. The Contracting Agency reserves the right, however, to require the Contractor to furnish samples of the steel proposed for use and to determine to its satisfaction that the steel meets the specification requirements. Steel rail elements, fittings, end section hardware, and bolts may be accepted by the Engineer based on the Manufacturer's Certification of Compliance.

9-16.4 Wire Mesh Slope Protection

9-16.4(1) General

All metal material used in the construction of wire mesh slope protection shall be new and galvanized. Imperfectly galvanized material or material upon which serious abrasion of galvanizing occurs will not be acceptable.

9-16.4(2) Wire Mesh

The galvanized wire mesh shall consist of No. 9 gage (3.76-millimeter diameter) commercial quality zinc coated steel wire, 50-millimeter × 50-millimeter diamond mesh chain link conforming to the requirements of AASHTO M 181. Galvanizing shall conform to the requirements of ASTM A 392 except the mass of zinc coating shall be 245 grams per square meter minimum, of uncoated wire surface. Galvanizing shall be done before weaving.

The wire mesh fabric shall have knuckled selvages.

Alternate wire mesh for slope protection shall be double twisted mesh. The mesh shall be of nonraveling construction and consist of a uniform double twisted hexagonal mesh of hot-dip galvanized steel wire having a diameter of 3.05 millimeters after galvanization. The wire shall be galvanized prior to weaving into the mesh and shall conform to ASTM A 641M, Class 3, Finish 5, Soft temper. The minimum tensile strength shall be 414 megapascals when tested in accordance with ASTM A 370. Openings shall be hexagonal in shape and uniform in size measuring not more than 83 millimeters by 114 millimeters, approximately 5800 square millimeters. Lacing wire shall be the same specifications as the wire used in the wire mesh except that its diameter shall be 2.2 millimeters after galvanization.

Edges shall be mechanically selvaged in such a manner as to prevent unraveling, and shall develop the full strength of the mesh. The wire used for the selvage shall have a nominal diameter of 3.9 millimeters.

9-16.4(3) Wire Rope

Wire rope shall be 16-millimeter diameter zinc coated steel structural wire rope conforming to the requirements of ASTM A 603M, Class A.

9-16.4(4) Hardware

All rings shall be drop-forged steel, heat treated after forging. Lightweight wire rope thimbles weighing approximately 6.26 kilograms per hundred shall be used with the 12.7-millimeter diameter wire rope. Wire rope clips may be drop-forged steel or cast steel for use with 12.7-millimeter wire rope. All rings, thimbles, wire rope clips, and U-bolts shall be galvanized in accordance with AASHTO M 232, Class C, except castings shall be Class A, and forgings shall be Class B.

9-16.4(5) Hog Rings and Tie Wire

Hog ring fasteners and tie wire shall be manufactured of 9 gauge steel wire meeting Federal specification QQ-W-461 (AISI numbers 1010 and 1015) finish 5; medium hardness and tensile strength; Class 3 coating.

9-16.4(6) Grout

When required, grout for anchors shall consist of one part Portland cement and three parts of clean sand. The Portland cement shall conform to the requirements of Section 9-01.2(1).

9-16.4(7) Anchor Rods

Anchor rods shall be of good quality steel. The eye may be drop forged or formed with a full penetration weld and shall develop 100 percent of the rod strength. The anchor rod shall be galvanized in accordance with ASTM A 153.

9-16.5 Vacant

9-16.6 Glare Screen

9-16.6(1) General

All material used in the construction of the fence shall be new. Iron or steel material shall be galvanized or aluminum coated as specified. Imperfectly galvanized or aluminum coated material, or material upon which serious abrasions of galvanizing or aluminum coating occur, will not be acceptable.

9-16.6(2) Glare Screen Fabric

Glare screen fabric shall consist of diamond woven wire mesh. The fabric wire may be 3.75-millimeter diameter aluminum alloy complying with the Aluminum Association requirements for alloy 6061T94, or it may be 3.75-millimeter diameter (9 gage) iron or steel wire which shall meet all of the requirements of ASTM A 392 galvanized or A 491 for aluminum coated, except that galvanizing of Type 2 glare screen fabric shall be not less than 245 grams per square meter and shall be done before weaving. Aluminum coating shall be Class II.

Type 1 glare screen mesh size shall be approximately a 25-millimeter diamond. Type 2 glare screen mesh size shall be a maximum of 89 millimeters vertical and 140 millimeters horizontal. The design shall permit the slats to be installed in a vertical position as shown in the Plans without distortion of the slats.

9-16.6(3) Posts

Line posts for Type 1 glare screen shall be 38.1 millimeters by 47.6 millimeters hot-dip galvanized steel H column with a minimum mass of 4.17 kilograms per meter. Line posts for Type 2 glare screen shall be 49.5 millimeters by 57.2 millimeters hot-dip

galvanized steel H column with a minimum mass of 59.5 kilograms per meter, or 50.8-millimeter inside diameter hot-dip galvanized steel pipe with a nominal mass of 54.3 kilograms per meter provided only one type shall be used on any one project.

End, corner, brace, and pull posts shall be 50.8 millimeter inside diameter hot-dip galvanized steel pipe with nominal mass of 54.3 kilograms per meter. Intermediate pull posts (braced line posts) shall be H column as specified for line posts. Brace post sleeves shall be 63.5-millimeter inside diameter hot-dip galvanized steel pipe with nominal mass of 86.2 kilograms per meter.

The base material for the manufacture of steel pipes used for posts shall conform to the requirements of ASTM A 53, except the mass tolerance on tubular posts shall be applied as provided below. The base material for the manufacture of steel H columns shall meet the requirements of ASTM A 675M.

Posts provided for glare screen will have an acceptance tolerance on the mass per meter, as specified, equal to plus or minus 5 percent for tubular and H-section posts. This tolerance will apply to each individual post.

All posts, braces, and top rails shall be hot-dip galvanized. They shall have a minimum average of 550 grams zinc coating per square meter of surface area with no individual test being below 490 grams zinc coating per square meter of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average of mass of coating is defined as a 300-millimeter piece cut from each end of the galvanized member.

9-16.6(4) Tension Wire

Top and bottom tension wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 245 grams per square meter of surface area.

9-16.6(5) Cable

The tension cable shall be 6-millimeter diameter aluminum coated or hot-dip galvanized, 7 wire strand steel cable conforming to the requirements of ASTM A 474 for aluminum coated or A 475 for galvanized, High-Strength Grade. Galvanizing shall be Class A.

9-16.6(6) Cable and Tension Wire Attachments

All tension wire and cable attachments shall be hot-dip galvanized steel conforming to the requirements of AASHTO M 232 unless otherwise specified. Eye bolts shall have either a shoulder or a back-up nut on the eye end and be provided with an eye nut where needed or standard hex nut and lock washer and be 16-millimeter diameter for tension cable and 10-millimeter diameter for tension wire and of sufficient length to fasten to the type of posts used. Where the eye bolt is to be installed through a pipe section, two lead washers and one steel washer shall also be provided. Turnbuckles shall be of the shackle end type, 13-millimeter diameter, with standard take-up of 150 millimeters and provided with 10-millimeter diameter pins. Thimbles shall be light weight wire rope thimbles for use with 6-millimeter diameter cable. Wire rope clips shall have a U-bolt diameter of 8 millimeters for use with 6-millimeter diameter cable. Anchor shackles shall be 10-millimeter diameter with a minimum distance between eyes of 27 millimeters and a pin diameter of 11 millimeters. Seizing shall be 0.8-millimeter diameter galvanized annealed iron wire.

9-16.6(7) Slats

9-16.6(7)A Wood Slats

Wood slats shall be 10 millimeters by 60 millimeters by the height designation of the fence. Material shall be finished and treated cedar or redwood and shall be free from loose knots, cracks, and other imperfections. A dimensional tolerance of plus or minus 2 millimeters in width or thickness is allowed provided that the maximum space between slats does not exceed 19 millimeters.

9-16.6(7)B Plastic Slats

Plastic slats shall be 10 millimeters by 60 millimeters by the height designation of the fence. They shall be manufactured from tubular polyethylene color pigmented material consisting of high density virgin polyethylene and color pigments, designed to retard ultraviolet penetration. The material shall have a minimum wall thickness of 0.76 millimeters plus or minus 0.8 micrometers and shall remain flexible without distortion and without becoming brittle through a temperature range of -57°C to + 121°C. Tensile strength shall be at least 25 megapascals and the melt index shall not exceed .25.

Plastic slats shall be retained in place by means of U-shaped retainer members at the bottom and top of the fence. Retainer members shall be of the same material as the slats.

The color for plastic slats will be approved by the Engineer from samples submitted by the Contractor or supplier.

9-16.6(8) Fittings

Fittings shall be malleable cast iron or pressed steel and galvanized in accordance with the requirements of AASHTO M 232.

Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

9-16.6(9) Fabric Bands and Stretcher Bars

Fabric bands shall be 3 millimeters by 25 millimeters nominal and stretcher bars 5 millimeters by 19 millimeters nominal. Nominal shall be construed to be the area of the cross-section of the shape obtained by multiplying the specified width by thickness. A variation of minus 5 percent from this theoretical area shall be construed as “nominal” size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626.

9-16.6(10) Tie Wire

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211M for alloy 1100 H14 or 9 gage galvanized wire meeting the requirements of AASHTO M 279M. Galvanizing shall be Class 1.

9-16.7 Vacant

9-16.8 Weathering Steel Beam Guardrail

9-16.8(1) Rail and Hardware

Steel for rail elements and terminal sections shall conform to ASTM A 606 or ASTM A 607. Bolts, nuts, and washers for installation of the weathering steel shall be manufactured from steel conforming to ASTM A 242M and shall not be galvanized. If required, 150-millimeter channels and fittings shall conform to ASTM A 242M. In addition, all steel for the guardrail components shall conform to one of the following chemical compositions, percent (ladle):

Composition:

	C	Mn	P	S	Si	Cu	Cr	Ni	Zr
No. 1	0.12 Max.	0.20 to 0.50	0.07 to 0.15	0.05 Max.	0.25 to 0.75	0.25 to 0.55	0.30 to 1.25	0.65 Max.	
No. 2	0.12 Max.	0.50 to 1.00	0.12 Max.	0.05 Max.	0.20 to 0.90	0.50 Max.	0.40 to 1.00	1.00 Max.	0.10 Max.

Blast cleaning or pickling to remove mill scale will not be required. All fabricated steel parts shall be handled with care to avoid gouges, scratches, and dents. The steel shall be kept clean of all foreign material, such as paint, grease, oil, chalk marks, crayon marks, concrete spatter, or other deleterious substances. Natural oxidation of the steel will not be considered foreign material. Storage in transit, in open cars and trucks, for an extended period will not be permitted. Steel parts stored outside in yards or at job sites shall be positioned to allow free drainage and air circulation.

9-16.8(2) Anchors

Guardrail anchors may either be furnished as provided in Section 9-16.3(5) or they may be nongalvanized and fabricated from steel conforming to ASTM A 242M with the exception that all Type 1 anchors shall have galvanized cable and fittings as specified in Section 9-16.3(5).

9-17 FLEXIBLE GUIDE POSTS

9-17.1 General

Flexible guide posts shall be made of a flexible, nonwarping, nonmetallic, durable plastic material; shall be resistant to damage due to impact, ultraviolet light, ozone, hydrocarbons, and other effects of atmospheric weathering; shall resist stiffening with age; and shall be designed for a minimum life equaling 60 months of outdoor service.

The material composition of flexible guide posts subsequently furnished shall not vary from that of the samples upon which the Olympia Service Center Materials Laboratory preapproval is based. If analysis by the Materials Laboratory determines there is a change in material composition, such change shall constitute grounds for rejection and/or removal from the preapproved list or the Qualified Products List.

The post system shall be designed for permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

Each flexible guide post shall be permanently identified with the manufacturer's name, and the month and year of fabrication. Ground mounted guide posts shall have a permanent mark indicating the recommended burial depth. The letters shall be solvent resistant, a minimum of 5 millimeters in height, and permanently affixed to the post.

Unless otherwise specified, the color of the guide post shall be white or brown as indicated in the Plans. Guide post length shall be in accordance with Section 8-10.3 and the Standard Plans.

The reflective panel on a flat or elliptical guide post shall have a minimum width of 75 millimeters facing traffic. The reflective sheeting shall have a minimum area of 15 000 square millimeters (75 millimeters by 200 millimeters). The reflective panel on a round guide post shall have a 200-millimeter minimum band of reflective sheeting visible for 360 degrees.

9-17.2 Laboratory Tests

Ten guide posts of each model shall be conditioned in an oven for two hours at 102°C, plus or minus 2°C. After conditioning, the guide posts shall be bent backwards at 90 degrees from the vertical to simulate a field impact. The guide post shall, without cracking, recover to within 10 degrees of its original position within five minutes. Color shall remain unchanged. Any appreciable change in color, cracking on more than one face, or not returning to within 10 degrees of vertical, is considered a failure. At least 70 percent of the posts must pass to be considered for preapproval.

The same ten guide posts tested for heat resistance shall be tested for cold resistance. The guide posts shall be conditioned for 24 hours at -29°C, plus or minus 2°C, then subjected to the same testing as for heat resistance. The guide posts shall conform to the same cracking, color, and recovery standards as for heat resistance. At least 70 percent of the posts must pass to be considered for preapproval.

Three guide posts of each model shall be subjected to deflection testing. The guide posts shall be fixed near the base in such a way that 1220 millimeters of the post is cantilevered. The guide posts shall then be loaded 12 millimeters from the free end until collapse is observed. (Collapse is defined as the point at which the guide post can no longer resist any further loading.) The stress at collapse shall be calculated as follows:

$$L = \frac{p}{b}$$

Where: L = load per unit width
p = unit load (kilograms)
b = width or diameter (millimeters)

L shall not be less than: 0.0102 for round posts, or 0.0157 for flat or elliptical posts. Any load below these values or cracking of more than one face, of any of the guide posts is considered a failure.

The three guide posts subjected to deflection testing shall be subjected to cyclic loading with an amplitude of 50 millimeters at the tip, with a cycle testing machine. Each guide post shall be cycled 30,000 times at 60 cycles per minute. When the cyclic tests are completed, the three guide posts shall again be subjected to deflection testing. The average load of the posts after cyclic loading shall be a minimum of 80 percent of the average load of the posts tested before cyclic loading. A value below this limit is considered a failure.

Three guide posts of each model shall be subjected to a 2.5-kilogram deflection test. The guide posts shall be fixed near the base in such a way that 1220 millimeters of the post is cantilevered. The guide post shall then be loaded 12 millimeters from the free end with a 2.5-kilogram mass. A deflection greater than 740 millimeters is considered a failure.

A 225-millimeter specimen from the unreflectorized portion of each of three guide posts shall be prepared. The specimens shall be cycled at 1,000 hours in a weatherometer in accordance with ASTM G 53 (3 hr. 60C UV, 3 hr. 50C CON). The specimens shall show no signs of delamination, distress, or discoloration. Physical properties of tensile strength and rigidity shall be maintained within 80 percent of the unconditioned values.

9-17.3 Field Tests

Ten guide posts of each model, supplied in accordance with Section 9-17.4, shall be installed by the manufacturers representative at the Olympia Service Center Materials Laboratory designated test site. Anchoring materials shall be driven such that the anchor is flush with, or below, the ground level. The test temperature shall be at or below 10°C.

The ten guide posts shall be struck seven times at 55 kilometers per hour, then two times at 90 kilometers per hour, by a car or equivalent hood and bumper device with a 450-millimeter height. After each impact, the delineators shall be inspected for the following criteria:

1. A minimum of 50 percent of the reflective sheeting shall be retained undamaged. An area of damage greater than 50 percent is considered a failure.
2. If the guide post leans more than 10 degrees from vertical it is considered a failure.
3. Any cracking, other than surface cracking evident on only one face of the post, is considered a failure.
4. Pullout in excess of 75 millimeters is considered a failure.

If an individual guide post fails any one of the above criteria in the 55 kilometers per hour series of impacts, the product is unacceptable. At least 70 percent of the guide posts must pass each criteria in the 90 kilometers per hour series of impacts to be acceptable.

9-17.4 Pre-approval

In order for a particular model of flexible guide post to become preapproved, the following conditions must be met:

1. The manufacturer must submit a written request for pre-approval along with samples for each model to be tested to: Materials Engineer, Department of Transportation Materials Laboratory, P.O. Box 167, Olympia, WA 98504. Requests shall identify the model for which approval is being requested. Samples shall be complete with reflective panel attached, and shall be accompanied by the manufacturer's written installation procedures.

2. The guide posts will be field impact tested by the Olympia Service Center Materials Laboratory to verify compliance with these specifications.
3. In lieu of Olympia Service Center Materials Laboratory testing, the Lab will accept the results of pre-approved testing performed by the manufacturer or other agencies under the following conditions:
   a. The Olympia Service Center Materials Laboratory is informed of the pre-approval testing sufficiently in advance in order to attend and observe. Attendance will be at the discretion of the Materials Laboratory.
   b. The results of the testing shall be reported in sufficient detail to enable the Olympia Service Center Materials Laboratory to evaluate compliance with these specifications.
4. The manufacturer must submit a certified test report, including test data developed by an approved testing laboratory, which demonstrates that the guide post complies with the requirements of these specifications. Certified test data supplied by the manufacturer shall be subject to verification by appropriate tests conducted by the Olympia Service Center Materials Laboratory.

Frequency of field testing, evaluation, and preapproval updating shall be at the sole discretion of the Olympia Service Center Materials Laboratory.

9-18 PRECAST TRAFFIC CURB AND BLOCK TRAFFIC CURB

9-18.1 Precast Traffic Curb

9-18.1(1) Aggregates and Proportioning

The cement, fine and coarse aggregate, and reinforcing steel to be used in the manufacture of precast concrete traffic curb shall meet the following requirements:

Portland cement shall conform to the requirements of Section 9-01 except that it may be Type I Portland cement conforming to AASHTO M 85.

Aggregates shall conform to the requirements of Section 9-03 except that they shall be uniformly graded up to a maximum size of 9 millimeters and shall contain sufficient fine fractions to permit securing the type of surface finish specified herein. The aggregate shall be approved by the Materials Laboratory before it is used.

Reinforcing steel shall conform to the requirements of Section 9-07.1.

The cement concrete mix shall be composed of not less than 1 part Portland cement to approximately 2 parts of fine aggregate and $3^1/_4$ parts of coarse aggregate adjusted to secure proper workability. The Contractor will be allowed to use a different concrete mix if approved by the Engineer, provided that it develops not less than 28 megapascals compressive strength when tested at the age of 28 days.

9-18.1(2) Mixing

The mixers shall be kept in good repair and be equipped with an automatic timing device and a positive device for regulating the quantity of water added to each batch. Such a device must be approved by the Engineer before use.

After all materials, including water, have been placed in the mixer, the materials shall be mixed for a period of not less than $1^3/_4$ minutes, or as much longer as may be necessary to produce a thorough and uniform mixture of the concrete. No water shall be added to any batch after the completion of the initial mixing period. Each batch of concrete shall be completely emptied from the mixer before placing more materials in it. A batch which has not been placed within 30 minutes from the time water was first added shall not be used.

The amount of water in the concrete shall be kept at a minimum consistent with the manufacture of dense curb, free from air bubbles and surface defects in excess of the tolerance limits specified.

9-18.1(3) Forms

Forms shall be of concrete or steel. The use of forms or molds made of plaster of paris, wood, or other absorptive material will not be permitted.

Bulkheads shall be tight fitting so that there is no leakage of mortar between the bulkhead and form.

The materials and methods used for lubricating the forms shall be such that they will not result in discoloration of the curb at any time. A minimum quantity of lubricant shall be used and all excess lubricant shall be removed.

9-18.1(4) Placing Concrete

The concrete shall be consolidated by external vibration, or by other means if approved by the Engineer, to produce a dense concrete throughout, having a minimum of air bubbles and honeycombing.

Reinforcing steel shall be placed and maintained in its proper position as shown in detail drawings.

Curb or buttons shall not be manufactured in an atmospheric temperature of less than 10°C.

9-18.1(5) Removal of Forms

The curb shall be removed from the molds or forms in accordance with the instructions or by some other method acceptable to the Engineer.

The loosening of the curb from the molds shall be carefully performed to avoid excessive shock and straining of the curb. When, in the opinion of the Engineer, undue shock is required to remove the curb from the molds, the stripping operation shall be deferred until such time as the curb may be removed without breakage.

9-18.1(6) Curing Concrete

Immediately after the concrete has been placed and consolidated in the mold, each unit shall be placed in a curing room fitted with water sprays and maintained at a relative humidity of not less than 90 percent and a temperature of not less than 15°C, nor more than 37°C. Each unit shall remain in the curing room for a period of not less than 10 days, except that if Type III cement is used, the period in the curing room may be reduced to 5 days.

9-18.1(7) Finish

The curb shall have a smooth, glassy finish on all exposed surfaces.

Excess honeycombing in the back of the curb may be cause for rejection of the curb. Honeycombing areas in the back of the curb which, in the opinion of the Engineer, are not detrimental to the curb need not be patched. The workmanship of the bottom finish shall be such that no mechanical interlocking of the mortar bed and the curb bottom or anchor groove will occur.

9-18.1(8) Surface Treatment

As soon as the units have been taken out of the curing room and thoroughly surface dried to a depth of at least 6 millimeters, two coats of a water-repellent compound, meeting the requirements of Section 9-18.4, shall be brush applied. When the first coat has dried, the second coat of water-repellent compound shall be applied.

9-18.1(9) Dimensions and Shape

The curb shall conform to the dimensions and shape shown in the Plans within a tolerance of 6 millimeters in length and 3 millimeters in alignment.

9-18.1(10) Curb Lengths

Curb lengths shall be in accordance with the Standard Plans, except in special cases where different lengths are specified. Circular curbing shall be made only for such radii as called for in the detail plans.

9-18.1(11) Defective Curb

Not more than 2 percent of the top area in any one piece of curb shall be defective, and not more than 5 percent of the total length of the top corners of reflecting faces in any one piece of curb shall be broken or rounded. There shall be not more than 50 holes in any 1 meter of curb. All curb having defects in excess of any of the above will be rejected immediately upon inspection after removal from the forms. However, failure to reject the

curb at that time will not ensure its final acceptance. Ninety percent of the curb laid shall not have more than 10 percent of the maximum allowable number of defects specified above.

An air hole shall be defined as any hole 3 millimeters or larger in diameter or depth.

All defects within the limits permitted, apparent upon removal of forms, shall be repaired immediately.

The sum of the length of the lines of discoloration caused by a cracked mold in any one piece of curb shall not exceed 50 percent of the length of the curb, and the maximum length of any single line of discoloration shall not exceed 450 millimeters. 75 percent of the curb laid shall be entirely free from lines of discoloration. The employment of heat to obliterate lines of discoloration will not be permitted. The process used to obliterate lines of discoloration shall be subject to the approval of the Engineer.

The repairing of molds which are chipped or broken shall be done in a manner that the broken or chipped areas will not be apparent on the curb made in those molds.

All curb in which surface checking develops during the first five days after manufacture will be rejected.

Hidden air holes at or immediately below the exposed surface of the curb, in excess of the limits specified that are disclosed by testing the surface by means of a rubber hammer will be cause for rejection of the curb.

All curb in which cracking is in evidence immediately after removal from the molds will be rejected. A crack is defined as any separation of the concrete of a continuous length greater than 75 millimeters.

All curb which varies in dimensions, alignment, or surface contour in excess of the tolerance specified will be rejected.

Failure to comply with the plans, specifications, or instructions of the authorized representative of the Contracting Agency in the manufacture and laying of any curb will be cause for rejection of such curb.

9-18.1(12) Repairing Curb

Curb having defects which are not sufficient cause for its rejection shall be neatly repaired immediately after removal from the molds in a manner subject to the approval of the Engineer. However, no patching or other repairs shall be made without the permission of the Engineer. Patches shall be undercut if, in the opinion of the Engineer, this operation is necessary to achieve a satisfactory patch.

All holes larger than 2-millimeter diameter in the exposed surface of acceptable curb or buttons shall be filled with cement mortar.

9-18.1(13) Identification Marking

The date of manufacture, the length, and identification number corresponding to the detail layout shall be marked in black paint on the back or end of each piece of curb.

Rejected curb shall be marked on the back or end surfaces in a practical and semi-permanent manner to identify each cause of rejection.

9-18.1(14) Shipping

No unit of curb shall be shipped from the manufacturing plant prior to 21 days after manufacture, except, however, that if Type III cement has been used, the units may be shipped 14 days after manufacture.

9-18.1(15) Sampling and Inspection

The Contractor shall submit, for the approval of the Engineer, an advance sample of curb which shall be at least equivalent in color, surface texture, and bottom finish to the standard as set forth in these Specifications. No repairing of any kind shall be done on the advance sample. Upon approval, the advance sample shall be stored at the plant or site of manufacture in a location readily accessible to the Inspector where there is adequate daylight for examination. The advance sample shall be protected from damage and discoloration and shall be used as a standard of comparison for color, surface texture, and bottom finish for all curb manufactured. All curb furnished shall be equivalent in the foregoing respects.

The inspection at the plant will be made just prior to shipment, at which time examination will be made of the alignment, contour, color, cracks, surface damage or discoloration, broken corners or edges, and any other defects which may have developed, and to check the laboratory test reports for strength. However intermediate inspections may be made to determine surface checking and hidden air holes if it is impractical to examine for these defects at the final inspection.

9-18.2 Vacant

9-18.3 Block Traffic Curb

In construction of the block traffic curb, the Contractor shall have the option of using either length block shown in the plans, provided the same length block is used throughout the entire project.

The curb units shall be made from Portland cement and high quality sand and gravel, the proportions of which will be left to the discretion of the producer as long as the unit develops a minimum compressive strength of 11 megapascals at 28 days when tested for end loading.

The proportions of sand, gravel, and cement, the type of forms used, and the method of compacting the concrete in the forms shall all be such that as dense, smooth, and uniform a surface as is practicable for a concrete masonry unit is obtained on the finished curb units. The faces that are to be exposed shall be free from chips, cracks, air holes, honeycomb, or other imperfections except that if not more than 5 percent of the curb units contain slight cracks, small chips not larger than 13 millimeters, or air holes not more than 13 millimeters in diameter or depth, this shall not be deemed grounds for rejection. The units used in any contiguous line of curb shall have approximately the same color and surface characteristics.

9-18.4 Water-Repellent Compound

The water-repellent compound shall be a clear, penetrating type, silicone resin base compound containing no filler or other material which will leave a film on the surface of the masonry after it is applied. It shall be of such consistency that it can be applied readily by brush or spray to the masonry at atmospheric temperature down to –29°C.

The average absorption of three test specimens treated with the water-repellent compound, when tested in accordance with the methods used in the Olympia Service Center Materials Laboratory, shall not exceed 2 percent after being partially immersed in water for 72 hours immediately after curing.

The average moisture vapor transpiration (breathing) of three test specimens, when tested in accordance with the methods used in the Olympia Service Center Materials Laboratory, shall be not less than 50 percent at seven days.

The water-repellent compound shall be approved by the Olympia Service Center Materials Laboratory before it is used.

9-18.5 Sodium Metasilicate

Sodium metasilicate shall comply with ASTM D 537.

9-19 PRESTRESSED CONCRETE GIRDERS

9-19.1 Aggregates and Proportioning

The concrete for prestressed girders shall have the minimum compressive strengths as specified in the Plans. Aggregates used in the mix shall conform to the following: Coarse aggregate shall be in accordance with Section 9-03.1(4); and fine aggregate shall be in accordance with Section 9-03.1(2), Class I or Class II. The manufacturer may revise the grading of the coarse aggregate provided that the concrete mix design is qualified with the modified gradation.

The Contractor shall submit for approval a proposed mix design for each design strength. Included shall be evidence satisfactory to the Engineer that the proposed mix design will meet design requirements. Approval of the mix design will not preclude any requirements for the concrete placed in the girders.

The concrete mix shall be prepared and placed in accordance with the appropriate sections of Section 6-02.

Water used in mixing the concrete shall conform to the requirements of Section 9-25.1.

Cement shall conform to the requirements of Section 9-01.

Chemical admixtures shall conform to the provisions of Section 9-23.7.

The total chloride ion (C1-) content of the mixed concrete, expressed as a percent by mass of cement, shall not exceed 0.06 percent.

9-19.2 Reinforcement

Reinforcement shall meet the requirements of Section 9-07 and shall be placed in accordance with the requirements of Section 6-02.3(24).

9-21 RAISED PAVEMENT MARKERS (RPM)

9-21.1 Raised Pavement Markers Type 1

Markers Type 1 shall be plastic or thermoplastic markers composed of thermosetting resins, pigments, and inert ingredients and be of uniform composition. Markers shall not contain glass.

9-21.1(1) Physical and Chemical Properties

The markers shall be of uniform composition and free from surface irregularities, cracks, checks, chipping, peeling, spalling, crazing, and other physical damage interfering with appearance, application, or durability.

The markers shall be precast in the form of a single based spheriodal segment terminating in a rounded or squared shoulder where the spherical top meets the base. Markers shall be white or yellow.

The markers shall meet the following requirements:

Markers	Property	Thermoplastic Unit	Plastic Markers
Mass		grams	N/A 125 min.
Height		mm	16-20 16-20
Diameter	mm	97-103	97-103
Shoulder height	mm	2-6	2-6
Planeness of base:			
Concavity	mm	1.3 max.	1.3 max.
Convexity	mm	1.3 max.	1.3 max.
Reflectance (white only)	%MgO	80 min.	80 min.
Impact resistance	mm•kg	140 min.	140 min.
Titanium Dioxide (white only)	% by mass	N/A	21 min.

The markers passing laboratory tests will be field tested for approval. The field tests will include installation with control markers to determine relative adhesion and durability characteristics.

9-21.2 Raised Pavement Markers Type 2

The marker housing shall contain reflective faces as shown in the Plans to reflect incident light from either a single or opposite directions.

9-21.2(1) Physical Properties

The markers shall be not less than 100 millimeters nor more than 122 millimeters in width, and not more than 19 millimeters in height.

The outer surface of the marker housing shall be smooth except for the purpose of identification.

The base of the markers shall be substantially free from gloss or substances that may reduce its bond to adhesive.

The markers passing laboratory tests will be field tested for approval. The field tests will include installation with control markers to determine relative adhesion and durability characteristics.

9-21.2(2) Optical Requirements

1. Definitions: Horizontal entrance angle shall mean the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

   Observation angle shall mean the angle at the reflector between observer's line of sight and direction of the light incident on the reflector.

   Specific intensity (S.I.) shall mean candelas of the returned light at the chosen observation and entrance angles for each lux of illumination at the reflector on a plane perpendicular to the incident light.
2. Optical Requirements: The specific intensity of each reflecting surface at 0.2 degrees observation angle shall be not less than the following when the incident light is parallel to the base of the marker.

Hor. Ent. Angle	S.I.
0	0.28
20	0.11

   Yellow reflectors shall be not less than 60 percent and red reflectors not less than 25 percent of the above values.
3. Optical Testing Procedure: a random lot of markers will be tested. The markers to be tested shall be located with the center of the reflecting face at a distance of 1.52 meters from a uniformly bright light source having an effective diameter of 5.1 millimeters.

   The photocell width shall be 1.3 millimeters. It shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 5.3 millimeters. If a test distance of other than 1.52 meters is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

   Failure of more than 4 percent of the samples shall be cause for rejection of the lot.

9-21.2(3) Strength Requirements

Markers shall support a load of 910 kilograms as applied in the following manner:

A marker shall be centered over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be 25 millimeters high with an internal diameter of 75 millimeters and wall thickness of 6.4 millimeters. The load shall be slowly applied to the top of the marker through a 25-millimeter diameter by 25-millimeter high metal plug centered on the top of the marker.

Failure shall constitute either a breakage or significant deformation of the marker at any load of less than 910 kilograms.

9-21.3 Raised Pavement Markers Type 3

Raised pavement markers Type 3 shall meet the following requirements:

Impact resistance	1.7 joule, min.
Titanium Dioxide	21% (by mass), min., (white only)
Resin Content	20% (by mass), min.
Reflectance	80% min.
Concavity & Convexity:	
Transverse	1.6 mm, max.

Longitudinal	3.2 mm, max.

Dimensions for raised pavement markers Type 3 shall conform to the following:

	Length	Width	Depth
RPM Type 3-150 mm	150 mm	100 mm	19 mm
RPM Type 3-200 mm	200 mm	100 mm	19 mm
RPM Type 3-250 mm	250 mm	100 mm	19 mm
RPM Type 3-300 mm	300 mm	100 mm	19 mm

Shoulder depth shall be 6.4 millimeters. The ends shall be beveled from the top of the shoulder edge at a slope of 1:1 nominal.

Reflectance will be measured with a photovolt Reflectance Meter or its equivalent by comparing to a 78 percent standard.

9-22 MONUMENT CASES

9-22.1 Monument Cases, Covers, and Risers

Castings for monument cases, covers, and risers shall be gray iron castings conforming to the requirements of AASHTO M 105, Class 200B. The cover and seat shall be machined so as to have perfect contact around the entire circumference and full width of bearing surface. Dipping, painting, welding, plugging, or repairing defects will not be permitted.

9-23 CONCRETE CURING MATERIALS AND ADMIXTURES

9-23.1 Sheet Materials for Curing Concrete

Sheet materials for curing concrete shall meet the requirements of AASHTO M 171, Sheet Materials for Curing Concrete, except that only white reflective type shall be used.

9-23.2 Liquid Membrane-Forming Concrete Curing Compounds

Liquid membrane-forming compounds for curing concrete shall conform to the requirements of AASHTO M 148 (ASTM C 309) Type 1D or 2, Class A or B, except that the moisture loss when tested in accordance with WSDOT Test Method 814 shall be 2.50 grams for all applications.

Each lot of liquid membrane-forming curing compound shall be sampled at the project site and tested for acceptance. Liquid membrane-forming curing compound shall not be used in the absence of satisfactory test results.

9-23.3 Vacant

9-23.4 Vacant

9-23.5 Burlap Cloth

Burlap cloth shall meet the requirements of AASHTO M 182, Class 4.

9-23.6 Admixture for Concrete

Admixtures for use in concrete shall meet the following specifications:

Admixture	Specification	
Air entraining	AASHTO M 154	ASTM C 260
Water Reducing	AASHTO M 194 Type A	ASTM C 494 Type A
Set Retarding	AASHTO M 194 Type B	ASTM C 494 Type B
Water Reducing/ Set Retarding	AASHTO M 194 Type D	ASTM C 494 Type D
High Range Water Reducing	AASHTO M 194 Type F and G	ASTM C 494 Type F and G

In addition to the above specifications, admixtures proposed for use shall contain less than one percent chloride ion (Cl-) by mass of admixture.

Acceptance of admixtures will be based on Manufacturer's Certificate of Compliance. If required by the Engineer, admixtures shall be sampled and tested before they are used. Samples shall be submitted for testing 10 days prior to use.

9-23.7 Air-Entraining and Chemical Admixtures for Precast Prestressed Concrete

Air-entraining admixture shall meet the requirements of AASHTO M 154. Acceptance will be on the basis of a Manufacturer's Certification of Compliance.

If required by the Engineer, the air-entraining admixture shall be sampled and tested by the Materials Laboratory before use.

Chemical admixtures shall conform to the requirements of AASHTO M 194, Type A, B, D, or F. Approval of specific admixture products shall be required as a part of the annual approval of prestressed fabricators. Chloride ion content of chemical admixtures shall not exceed one percent by mass.

Acceptance will be on the basis of a Manufacturer's Certification of Compliance.

If required by the Engineer, the admixture shall be sampled and tested by the Materials Laboratory before use.

9-23.8 Waterproofing

Concrete made with waterproofing admixtures shall have a percent absorption after immersion and boiling of less than 5.0 percent at seven days and a volume of permeable voids less than 11.0 percent at seven days per ASTM C 642. The Contractor shall submit evidence in the form of test results showing compliance with these specifications, when they submit their concrete mix design.

If the concrete requires air entrainment, the Contractor shall also submit evifdence to the Engineer that the admixture will not adversely effect the air void system of the hardened concrete. Test results complying with ASTM C 457 shall be provided as evidence to satisfy this requirement.

9-23.9 Fly Ash

Fly ash shall conform to the requirements of AASHTO M 295 Class C or F including optional chemical requirements as set forth in Table 2 and with a further limitation that the loss on ignition shall be a maximum of 1.5 percent.

9-24 PLASTIC WATERSTOP

9-24.1 Material

The waterstops shall be fabricated from a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain any additional resins, plasticizers, inhibitors, or other material such that when the material is compounded, it shall meet the performance requirements given in these Specifications.

Single-pass reworked material of the same composition generated from the fabricator's waterstop production may be used. No reclaimed polyvinyl chloride shall be used.

All waterstops shall be molded or extruded in such a manner that any cross-section will be dense, homogeneous, and free from porosity and other imperfections.

The waterstops shall be symmetrical in shape, nominal 100 millimeters in width, by 5 millimeters thick, and a minimum of four ribs on each side of the bulb. The bulb thickness and diameter shall be as noted in the plans.

9-24.1(1) Tests of Material

The waterstops shall meet all of the physical and other test requirements of this material as defined in the Corps of Engineers Specifications for Polyvinyl Chloride Water Stop CRD-C572, except that the tear resistance of the material shall be not less than 286 kilograms per meter. The Contractor shall furnish such sample material as required by the Engineer for the purpose of making tests.

9-25 WATER

9-25.1 Water for Concrete

It shall be the Contractors responsibility to perform the following tests and report the results to the Engineer.

Water for mortar or concrete shall meet the requirements of ASTM C 94 Table 1 and 2.

Water from mixer washout operations may be used in concrete provided it meets or exceeds the following additional requirements:

1. Concrete with water from mixer washout operations shall not be used in bridge roadway deck slabs, flat slab bridge superstructures, modified concrete overlays, or prestressed concrete.
2. Specific Gravity shall not exceed 1.07.
3. Alkalies, expressed as [Na(4)O+0.658K92)O], shall not exceed 600 ppm.
4. Shall be free of coloring agents.
5. Prior to using wash water in concrete, the Contractor shall certify that all admixtures used in the concrete producer's plant operations are from the same manufacturer. If the wash water contains admixtures from different manufacturers, the Contractor shall provide test results per Section 6-02.3(3).
6. All tests to verify that the physical and chemical requirements are met, shall be conducted on the following schedule:
   a. The physical requirements shall be tested on weekly intervals for four weeks and thereafter on monthly intervals.
   b. The chemical requirements shall be tested on monthly intervals.
   c. The specific gravity shall be determined daily in accordance with ASTM D 1429, Test Method D.

The Contractor shall use the services of a Laboratory that has a equipment calibration/verification system, and a technician training and evaluation process per AASHTO R-18 to conduct all tests. The laboratory shall use testing equipment that has been calibrated/verified at least once within the past 12 months to meet the requirements of each test procedure in accordance with the appropriate section of AASHTO R-18. Documentation of tester qualifications and equipment verification records shall be maintained and available for review by the Contracting Agency upon request. Agency reviews of the laboratory facility, testing equipment, personnel, and all qualification, calibration, and verification records will be conducted at the Contracting Agency's discretion.

9-25.2 Water for Plants

Water for plants shall not contain dissolved or suspended matter which will be harmful to the plant material on which it is to be used.

9-26 EPOXY RESINS

9-26.1 General

These Specifications cover 2-component epoxy resin systems for bonding plastic concrete or mortar to metal or hardened concrete, or for bonding hardened concrete or other materials to hardened concrete.

Epoxy resins used for patching external concrete shall have a concrete-gray color.

The epoxy resin systems shall be furnished in the type, grade, and class as specified according to current ASTM C 881.

9-26.1(1) Aggregate

Aggregate for epoxy mortar or concrete shall be clean, surface dry and inert (will not affect cure rate or physical properties of the epoxy resin system), and shall be of a quality and gradation suitable for Portland cement mortar or concrete. Sand meeting the requirements of Section 9-03.1(2) will be satisfactory.

9-26.1(2) Sampling

A representative sample of each component (500 milliliter of each) shall be taken either from a well-blended bulk lot prior to packaging or by withdrawing thief samples from no less than 5 percent of the containers comprising the lot or shipment. Instead of the foregoing, packaged materials may be sampled by a random selection of containers of each component from each lot.

9-26.1(3) Rejection

Except as noted otherwise, the entire lot of both components may be rejected if samples submitted for test fail to meet any requirements of this specification.

9-26.1(4) Packaging and Marking

A. Packaging. The two components of the epoxy resin system furnished under these Specifications shall be supplied in separate containers which are nonreactive with the materials contained. The contents of each container shall be such that the recommended proportions of the final mixture can be obtained by combining one container of one component with one container of the other component.

B. Marking. Containers shall be identified as “Component A — Contains Epoxy Resin” and “Component B — Contains Curing Agent” and shall show the type, grade, class, and mixing directions as defined by these Specifications. Each container shall be marked with the name of the manufacturer, the lot or batch number, the date of packaging, and the quantity contained.

Potential hazards shall be so stated on the package in accordance with the Federal Hazardous Products Labeling Act and State of Washington, Department of Labor and Industries Regulations for Shipment of Hazardous Products.

9-26.1(5) Certification

If requested by the Contracting Agency, the manufacturer of the epoxy resin system shall certify that components A and B meet the requirements of this specification before a sample will be accepted for testing by the Contracting Agency. Such certification shall consist of either a copy of the manufacturer’s test report or a statement of the manufacturer, accompanied by a copy of the test results, that components A and B have been sampled and tested. Such certifications shall indicate the date of testing and shall be signed by an authorized agent of the formulator or manufacturer.

9-26.1(6) Acceptance

Acceptance of a batch lot or shipment of the material for use on the project shall be on the basis of laboratory tests of samples, as specified in Section 9-26.1(2) representing the particular batch or shipment of materials supplied. These tests will be performed at the Olympia Service Center Materials Laboratory. A period of 10 days should be allowed for testing, following receipt of samples in the laboratory.

9-26.2 Adhesive for Lane Markers

9-26.2(1) Description

The adhesive shall be furnished as two components, each packaged separately. The components shall have the following composition:

Package A	**Parts by Mass**
Epoxy Resin	100.0
Titanium Dioxide	4.55
Oleophillic Fumed Silica	2.28
Talc	37.97
Package B	
N-Aminoethyl Piperazine	22.53
Nonylphenol	50.88
Carbon Black	0.14
Silica	25.32
Talc	50.63
Oleophillic Fumed Silica	2.28

At the time of use, the contents of packages A and B shall be thoroughly dispersed by mixing. One volume or mass of Package A shall be mixed with one volume or mass of Package B until a uniform gray color is achieved. The maximum acceptable variation in mix ratio shall be five from the 50/50 ratio (45A to 55B or 55A to 45B). The mix ratio shall be determined by analysis for Nitrogen percentage in the mixed and cured adhesive.

9-26.2(2) Raw Materials

Raw materials for the adhesive shall meet the following specifications:

1. Epoxy Resin — Viscosity, 70-100 poise at 25 C; epoxide equivalent 175-200; color (Gardner), 5 maximum; manufactured from epichlorohydrin and bisphenol A. The reactive diluent shall be either butane diol diglycerol ether or para tertiary butyl phenyl/glycidal ether.
2. High purity fumed silica — surface treated with a silicone oil, with the following properties: appearance, fluffy white powder; surface area, N2 B.E.T. method; 100 ± 20 M^2/g; mass percent carbon, 4.5 minimum; ignition loss (dry basis) 2 hours at 1,000 C, 7 maximum; specific gravity, 1.8. Moisture, mass percent, 0.5 maximum.
3. Talc — Percent passing 325 mesh screen, 100 percent; oil absorption in grams/ 100 g. talc, 28-34; Hegman grind in oil, 3 minimum; purity, 98 percent, talc minimum.

4. N — Aminoethyl Piperazine — COLOR (APHA) 50 maximum; amine value, 1250-1350 based on titration which reacts with 3 nitrogens in the molecule; appearance, clear and substantially free of suspended matter.
5. Nonylphenol — Color (APHA) 50 maximum; hydroxyl number, 245-255; distillation range, degrees C at 760 mm, first drop 295 minimum, 5 percent 298 minimum, 95 percent 325 maximum; water, percent (K.F.) 0.05 maximum.
6. Carbon Black — TT-P-343, Form I, Class B.
7. Silica — percent passing through 45-micrometer screen, 98 percent minimum. Average particle size, 7 to 10 microns; oil absorption in grams per 100 g. silica, 25 to 31. Hegman grind, 3 minimum. Purity, 98 percent silica (SiO_2) minimum.

9-26.2(3) Physical Requirements of Mixed Adhesive

A blend of 1 part of component A and 1 part of component B shall exhibit the following properties:

Gel time (150 g. Batch)	5-10 minutes
Tensile strength 1.6 mm film between steel blocks cured 24 hours at 21°C	
Tested at 21°C	6.9 MPa (Min.)
Shore D Hardness	(Cured 24 hours at 21°C)
Tested at 21°C	70-80
Tested at 49°C	Min. 30
Deformation Temp.	Min. 49°C
Viscosity of Mixed Adhesive[1]	100-200 Pa·s

[1]Brookfield to Helipath spindal at 25°C.

9-26.2(4) Acceptance

Adhesive for lane markers may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance. The manufacturer shall certify that each batch of adhesive conforms to these specifications.

The lot or batch number shall appear on the certificates, on all samples, and on all lots of adhesives delivered. A 500-milliliter sample of the A and B components shall be sent to the Materials Laboratory by the supplier not less than ten days before using.

9-27 CRIBBING

9-27.1 Vacant

9-27.2 Vacant

9-27.3 Gabion Cribbing

9-27.3(1) Gabion Fabric

Gabions may be fabricated from either hexagonal twisted wire mesh or from welded wire mesh. Only one type of mesh and protective coating shall be used throughout a structure.

Baskets shall be furnished in the required dimensions with a dimensional tolerance of plus or minus 5 percent.

Wire for construction of gabions shall be either galvanized steel wire conforming to ASTM A 641M, Class 3, Soft Temper, or aluminized steel wire conforming to ASTM A 809, Soft Temper. The wire shall have a minimum tensile strength of 414 megapascals when tested in accordance with ASTM A 370.

9-27.3(2) Gabion Baskets

Gabion baskets 300 millimeter or greater in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 114 millimeters and the maximum area of any mesh opening shall not exceed 6450 square millimeters.

1. Hexagon Twisted Wire Mesh
   a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 3.05 millimeter galvanized steel wire or aluminized steel wire.
   b. Hexagonal wire mesh be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twist. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 3.7 millimeters so that the selvage is at least the same strength as the body of the mesh.
2. Welded Wire Mesh
   a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 2.7 millimeters. Wire shall be galvanized prior to fabrication.
   b. Welded wire mesh shall be formed in a uniform square pattern with openings 75 millimeters by 75 millimeters with a resistance weld at each connection in accordance with ASTM A 185.
   c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.55 millimeter per side with a minimum of 0.4 millimeter.
3. PVC Coating (for welded wire mesh only)

   Acceptance of PVC coating material shall be by certified test reports of an independent laboratory. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:
   a. Specific Gavity — In the range of 1.2 to 1.4, when tested according to ASTM D 792.
   b. Tensile Strength — Not less than 15.7 MPa, when tested according to ASTM D 638M.
   c. Modulus of Elasticity — Not less than 13.7 MPa at 100 Strain, when testing according to ASTM D 638M.
   d. Hardness — Shore “A” not less than -10°C when tested according to ASTM D 2240.

e. Brittleness Temperature — Not higher than -10°C when tested according to ASTM D 746.
f. Resistance to Abrasion — The percentage of the mass loss shall be less than 12 percent when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.
g. Salt Spray Exposure and Ultraviolet Light Exposure – The PVC shall show no effect after 3,000 hours of salt spray exposure according to ASTM B 117. The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3,000 hours using apparatus Type E and 63°C, when tested according to Practice D 1499 and Practice G 23. After the salt spray test and exposure to ultraviolet light as specified above, the PVC coating shall not show cracks, blister, split, nor show a noticeable change of color. In addition, the specific gravity, tensile strength, modulus of elasticity, and resistance to abrasion shall not change more than 6, 25, 25, and 10 percent respectively from their initial values.

9-27.3(3) Gabion Mattresses

Gabion baskets less than 300 millimeters in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 84 millimeters, and the maximum area of any mesh opening shall not exceed 3870 square millimeters.

1. Hexagonal Twisted Wire Mesh
   a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 2.2-millimeter galvanized steel wire or aluminized steel wire.
   b. Hexagonal wire mesh shall be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twisted. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 2.7 millimeters so that the selvage is at least the same strength as the body of the mesh.
2. Welded Wire Mesh
   a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 2.0 millimeters. Wire shall be galvanized prior to fabrication.
   b. Welded wire mesh shall be formed in a uniform rectangular pattern with openings 38 millimeters by 75 millimeters with a resistance weld at each connection in accordance with ASTM A 185.
   c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.55 millimeter per side with a minimum of 0.4 millimeter. The PVC coating shall be in conformance with Section 9-27.3(2).

9-27.3(4) Fasteners for Basket Assembly

The lacing wire shall be a nominal sized 2.18-millimeter galvanized steel wire or aluminized steel wire. Lacing wire shall have the same coating as the basket mesh.

Spiral binders, if used for joining welded wire panels shall be formed from 2.7-millimeter nominal diameter steel wire with a 75-millimeter pitch having the same specifications and coating as the wire mesh. Lacing wire may be used in lieu of spiral binders.

Alternate fasteners for basket assembly shall remain closed when subjected to a 4.15 megapascal tensile force when confining the maximum number of wires to be confined. Installation procedures and test results for alternate fasteners shall be submitted for approval.

Internal connecting wires shall be the same as required for lacing wire. Alternate stiffeners acceptable to the gabion manufacturer may be used.

9-27.3(5) Nonraveling Construction

The wire mesh shall be fabricated in a manner to be nonraveling. This is defined as the ability to resist pulling apart at any of the connections forming the mesh when a single strand in a section of mesh is cut.

9-27.3(6) Stone

Stone for filling gabions shall have a Degradation Factor of at least 30. The stone shall be dense enough to pass the unit-mass test described in Section 6-09.3(6)F. Stone shall meet the following requirements for gradation:

Sieve Size	Percent Passing
200 mm	100
150 mm	75-90
100 mm	0-10
Fracture	75

All percentages are by mass.

9-28 SIGNING MATERIALS AND FABRICATION

9-28.1 General

Unless noted otherwise in the Plans, permanent signs shall be constructed of sheet aluminum. Permanent signs which measure 900 millimeters or less on a side and are to be mounted on a single post may be constructed of single 3.4-millimeter fiberglass reinforced plastic panels. Temporary or construction signs may be constructed of either medium or high density overlay plywood. Sign overlay panels may be either 1.3-millimeter aluminum or 1.9-millimeter fiberglass reinforced plastic panels. All signs, except internally illuminated signs, shall be reflectorized.

See ASTM D 4956 for reflective sheeting type designations. Standard control signs and guide sign borders, letters, numerals, symbols, shields, and arrows shall be in accordance with the "Washington State Sign Fabrication Manual."

All STOP, YIELD, DO NOT ENTER, WRONG WAY, FREEWAY ENTRANCE, and HIGHWAY ENTRANCE signs shall be constructed entirely of Type III or IV reflective sheeting. All M series, I series, and D-10 series signs and all signs with blue or brown backgrounds shall be constructed entirely of Type II reflective sheeting unless otherwise specified. Background reflective sheeting for all other signs shall be as noted in the Plans. Sign legends for all other signs shall be constructed of Type III or IV reflective sheeting. Sign legends include: borders, letters, numerals, symbols, shields, and arrows. Reflective legend sheeting types shall not be mixed on individual signs.

9-28.1(1) Basis for Acceptance

Reflective sheeting shall be accepted on the basis of tests performed by the Materials Laboratory, or at the option of the Engineer, a manufacturer's certificate of compliance as outlined in Section 1-06.3. This certificate shall verify that the product meets all the requirements of Section 9-28.12.

The basis for acceptance of aluminum sign blanks and panels shall be a mill test certificate from the aluminum manufacturer attesting to the correct alloy and temper of the metal supplied. At the option of the Engineer, laboratory tests may also be performed to confirm metallurgical data.

It is expressly understood that the furnishing of certificates of compliance will not relieve the Contractor from the obligation to replace materials found defective after delivery to the project, nor will they prevent the Engineer from sampling material when it arrives on the project and subjecting it to such laboratory tests as they may deem appropriate or significant.

9-28.1(2) Inspection

All signs will be inspected at the fabricator's plant before shipment to the project. The inspection shall not be made until all materials have been tested and approved. Signs without a "FABRICATION APPROVED" decal will not be installed on the project with the exception of double-faced signs which do not receive decals or fabricator's stickers.

9-28.2 Manufacturer's Identification and Date

All signs shall show the manufacturer's name and date of manufacture on the back. Destination, distance, and large special signs shall show the manufacturer's name and the date of manufacture on the back, and the number of the sign as it appears in the plans in 75-millimeter series C black letters. Hand painted numbers are not permitted.

9-28.3 Corner Radius

All regulatory and warning signs shall have rounded corners with the exception of stop signs. Information and guide signs may have square cut corners. Borders for signs having square cut corners shall have a corner radius approximately 1/8 of the lesser side dimension of the sign up to a maximum radius of 300 millimeters. For signs with rounded corners, the borders shall be concentric with the rounded corners.

9-28.4 Extruded Windbeams and "Z" Bar

All multiple post and multiple panel signs shall be constructed and installed with horizontal extruded windbeams and "Z" bar, when required, as shown in the Plans or the Standard Plan. All bolt and rivet heads visible on the sign face shall be anodized or painted to match the sign area immediately surrounding the bolt or rivet head. Extruded windbeams and "Z" bar shall be accepted on the basis of a certificate of compliance from the manufacturer. Materials shall be as designated in Section 9-28.11.

9-28.5 Letter and Spacing Formula

Letter and arrow sizes shall be as specified in the Plans. Spacing formulas shall be those furnished by the manufacturer of the letters.

9-28.6 Destination Sign Messages

Destination sign messages, borders, shields, and symbols shall be direct applied unless other wise noted in the sign plans. All message components shall be one piece construction unless the least dimension exceeds available sheeting widths. All components shall have smooth, sharp cut edges. Components which are torn, wrinkled, or exhibit poor workmanship, will not be permitted.

Where specifically noted in the Plans, demountable components shall be utilized. Demountable messages, borders, shields, and symbols shall consist of the appropriate sheeting, or if non-reflective, paint applied to 0.8-millimeter aluminum. Shields and symbols shall be applied to 1.3-millimeter aluminum.

9-28.7 Process Colors

Transparent and opaque process colors used in silk screening sign messages shall be as recommended by the manufacturer. When properly applied, process colors shall perform satisfactorily for the expected life of the sheeting. Applied colors shall present a smooth surface, free from foreign material, and all messages and borders shall be clear and sharp. Sheeting shall conform to the retroreflective minimum values and color limits established for its type and color without regard to whether the color is integral to the sheeting or achieved by applying transparent colors to silver/white sheeting. There shall be no variations in color, and overlapping of colors will not be permitted.

Properly applied and cured process colors shall exhibit no blistering, bubbling, or loss of color or transparency when cleaned with a mild non-abrasive detergent solution. Minor loss of color may be detected when solvents such as kerosene, mineral spirits, heptane, or VM&P Naphtha are used to clean severely contaminated signs; e.g., paint vandalism. However, the colors shall not blister, bubble, peel, or be easily removed.

9-28.8 Sheet Aluminum Signs

Sheet aluminum signs shall be constructed of material conforming to ASTM B 209M alloy 6061-T6 or alloy 5052-H36 or H38. Alloy 5005-H34 may be used for sign overlays.

After the sheeting has been fabricated, the sheeting for all multiple panel signs shall be degreased, etched by immersion for a minimum of 5 minutes in a 50-milliliter per liter caustic etch solution at 50°C, followed, in order, by a water rinse, de-oxidation, water rinse, hot water rinse, and drying. The etching process shall produce a dull aluminum finish on both sides of the panel which will last the life of the sign. The treated panel surface shall be compatible with the opaque and reflective sheeting to be applied in accordance with the specifications. The Contractor may use an Alodine 1200 application for single panel signs in lieu of the above treatment. Aluminum signs over 3600 millimeters wide by 1500 millimeters high shall be comprised of vertical panels in increments of 600, 900, or 1200 millimeters wide. No more than one 600- and/or 900-millimeter panel may be used per sign. The Contractor shall use the widest panels possible. All parts necessary for assembly shall be constructed of aluminum, galvanized, or stainless steel in accordance with the plans. Sheet thickness shall be as follows:

Maximum Horizontal Dimension	Sheet Aluminum Thickness
Overlay panels	1.0 mm
Up to 500 mm	1.6 mm
500 mm to 900 mm, inclusive	2 mm
Over 900 mm	3 mm

The side dimension for a diamond shaped warning sign is considered to be the maximum horizontal dimension.

Before placing aluminum in contact with untreated steel, the steel surfaces shall be protected by proper cleaning and painted with a zinc-dust zinc oxide primer A-6-86 and two coats of aluminum paint D-1-57.

Metal shall be handled by device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting.

9-28.9 Fiberglass Reinforced Plastic Signs

Fiberglass reinforced plastic signs and overlay panels shall be constructed of a fiberglass reinforced thermoset polyester laminate. The sign panel shall be acrylic modified and UV stabilized for outdoor weathering ability.

The sign panel shall be stabilized to prevent the release of migrating constituents (such as solvents, monomers, etc.) over the expected life of the sign. The sign panel shall contain no residue release agents on the surface of the laminate so neither migrating constituents or release agents will be present in amounts which will interfere with any subsequent bonding operations.

The sign panel shall not contain visible cracks, pinholes, foreign inclusions, or surface wrinkles that would affect implied performance, alter the specific dimensions of the panel, or otherwise affect its serviceability.

The sign panel surface shall be wiped clean with a slightly water dampened cloth before applying reflective sheeting.

9-28.9(1) Mechanical Properties

All mechanical properties are stated as minimum requirements. The mechanical properties are measured in both the line direction of the panel and at 90 degrees to the line as noted in the appropriate ASTM test referenced.

Mechanical Property	Ave. Min. Requirement	ASTM Test
Tensile Strength	70 MPa	D638M
Tensile Modulus	8300 MPa	D638M
Flexural Strength	140 MPa	D790M
Flexural Modulus	830 MPa	D790M
Compression Strength	220 MPa	D695M
Compression Modulus	9700 MPa	D695M
Punch Shear	90 MPa	D732

9-28.9(2) Physical Properties

Sign Panels are to be 3.4 millimeters thick. Overlay panels are to be 1.9 millimeters thick. Panel thickness tolerance shall be plus or minus 0.13 millimeter. Panel tolerance on nominal length and width shall be plus or minus 3 millimeters for dimensions of 3600 millimeters or less and shall be within 3 millimeters of square per 3600-millimeter of length when measured in accordance with ASTM D 3841.

Panels shall be manufactured with smooth surfaces on both top and bottom of the panel.

Panel flatness of a 750-millimeter by 750-millimeter panel shall be measured by hanging the panel diagonally in suspension. The maximum deflection measured diagonally, parallel and perpendicular to the panel by lines drawn through the center of the panel, shall not exceed 12 millimeters. The panel shall then be hung diagonally in suspension in an oven for 48 hours at 82°C. The maximum deflection shall again be measured as previously noted and shall not exceed 12 millimeters. All measurements shall be made when panels are at ambient temperature.

Panels shall be pigmented to a visually uniform gray color within the MunselR range of N.7.5/to N.8.5/.

Panels shall have a maximum coefficient of lineal thermal expansion of 3.2×10-5 m/m/ °C. when tested in accordance with ASTM D696.

Panels shall be classified as to a minimum Grade II (weather resistant) panel as specified in ASTM D 3841 following 3,000 plus or minus 100 hour weatherometer test.

Panels shall contain additives designed to be less responsive to fire ignition and flame propagation. As such, the extent of burning shall not exceed 25 millimeters when tested in accordance with ASTM D 635.

Panels shall resist the impact energy of 27 newton meters applied with a hemispherical tipped object 25 millimeters in diameter.

The panels thermal stability for strength and impact resistance qualities shall not be appreciably affected over a temperature range of -54°C to 100°C.

Fiberglass reinforced plastic panels for signs shall be accepted on the basis of a certificate of compliance from the manufacturer as outlined in Section 1-06.3.

9-28.10 Plywood Signs

Plywood signs shall be constructed of medium or high density plywood and shall conform to the current requirements as set forth in “Production Standard for Construction and Industrial Plywood” published by the Product Standards Section of the National Bureau of Standards. The plywood shall be free of contaminants.

Face veneers shall be Grade B or better.

Core and crossband veneers shall be solid. Core veneers shall be jointed, and core gaps shall not exceed 3 millimeters in width.

The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the requirements for exterior type plywood.

High density plywood overlay shall have a minimum mass of 29 kilograms per 100 square meters of surface, shall be at least 0.3 millimeter thick before pressing, and have a minimum resin content of 45 percent based on the volatile free mass of fiber and resin exclusive of glue line.

Medium density plywood overlay shall have a minimum mass of 28 kilograms per 100 square meters of surface. It shall be at least 0.3 millimeter thick after application and have a minimum resin content of 17 percent based on the volatile free mass of resin and fiber exclusive of glue line.

The overlay shall have a sufficient resin content to bond itself to the plywood.

Plywood sign surfaces shall be cleaned thoroughly with lacquer thinner, heptane, benzene, or solvent recommended by the reflective sheeting manufacturer. The surface shall be sanded with light sandpaper or steel wool and wiped dry and clean with a clean cloth. The reflective sheeting shall then be applied. Plywood signs over 3600 millimeters wide by 1500 millimeters high shall be comprised of vertical panels in increments of 1200 millimeters or less. The Contractor shall use the widest panels possible.

Plywood Panel Thickness

Signs: up to 450 mm inclusive in width	9 mm minimum
Over 450 mm to 900 mm inclusive in width	13 mm minimum
Over 900 mm in width	16 mm minimum
Plywood shields on destinations signs	9 mm minimum
Multiple panel signs	16 mm minimum

9-28.11 Hardware

Bolts, nuts, and washers shall be of the same material for each attachment. All parts necessary for assembly shall be constructed of the materials listed below:

Hardware	Specification
Bolts	ASTM F 468 2024-T4 Aluminum ASTM A 307 Steel ASTM F 593 Stainless Steel
Washers	ASTM B 209M 2024-T4 Aluminum AASHTO M 183M Steel ASTM F 594 Stainless Steel
Nuts	ASTM F 467 2024-T4 Aluminum ASTM A 307 Steel ASTM F 593 Stainless Steel
Locknuts	ASTM F 467 2024-T4 Aluminum ASTM A 307 Steel ASTM F 593 Stainless Steel
Rivets	ASTM B 316M 6061-T6 Aluminum ASTM B 316M 6053-T61 Aluminum
Post Clips	ASTM B 179 356-T6 Aluminum

Windbeam	ASTM B 221 6061-T6 Aluminum
Angle and "Z" Bar	ASTM B 221 6061-T6 Aluminum AASHTO M 183M Steel
Strap and Mounting Bracket	ASTM A 666, Type 201

All steel parts shall be galvanized per ASTM A 123. Steel bolts and related hardware shall be galvanized per ASTM A 153M or B 695.

9-28.12 Reflective Sheetings

Type I and Type II reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface. Type III and Type IV reflective sheeting shall consist of spherical or prismatic lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. Type VII reflective sheeting shall consist of unmetallized prismatic lens formed in a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. All sheeting shall be weather resistant and have a protected pre-coated adhesive backing. Type II reflective sheeting shall contain an identifying marking, such as a water mark, which is visible after sheeting application. The marking shall not adversely affect the performance or life of the sheeting.

The reflective sheeting shall have the following minimum coefficient of retroreflection values at 0.2 degrees and 0.5 degrees observed angle expressed as average candelas per lux, per square meter of material. Measurements shall be conducted in accordance with ASTM E 810.

Type I Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER-WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	70	50	25	9.0	14	4.0	1.0
0.2°	+30°	30	22	7.0	3.5	6.0	1.7	0.3
0.5°	-4°	30	25	13	4.5	7.5	2.0	0.3
0.5°	+30°	15	15	4.0	2.2	3.0	0.8	0.2

Type II Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	140	100	60	30	30	10	5.0
0.2°	+30°	60	36	22	10	12	4.0	2.0
0.5°	-4°	50	33	20	9.0	10	3.0	2.0
0.5°	+30°	28	20	12	6.0	6.0	2.0	1.0

Type III Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-4°	250	170	100	45	45	20
0.2°	+30°	150	100	60	25	25	11
0.5°	-4°	95	62	30	15	15	7.5
0.5°	+30°	65	45	25	10	10	5.0

Type IV Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	FLUORESCENT YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	210	35	35	20	7.0
0.2°	+30°	80	54	92	9	9	5.0	2.0
0.5°	-4°	135	100	100	17	17	10	4.0
0.5°	+30°	55	37	52	6.5	6.5	3.5	1.4

Type VII Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	FLUORESCENT ORANGE
0.2°	-4°	200
0.2°	+30°	120
0.5°	-4°	80
0.5°	+30°	50

The wet performance measurements on unweathered sheeting shall be conducted in accordance with one of the following methods:

(1) The standard rainfall test specified in Federal Specification LS 300C and the brightness of the reflective sheeting totally wet by rain shall not be less than 90 percent of the above values.

(2) Samples shall be submerged in a tank of clean water (approximately 22°C) for a period of 5 minutes. Reflex-reflective performance of the sheeting shall be viewed in a darkened room by reflected light through the surface of the water or through a transparent plane surface of the tank parallel to the sample surface. Light source shall be such as a hand flashlight held close to the eye. The wet sheeting shall show no apparent loss of reflective performance as compared to dry material.

The sheeting shall conform to the applicable daytime color and luminance factor requirements of ASTM D 4956 when tested instrumentally in accordance with Section 8.4 of that specification; OR, the diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparison shall be made under north daylight or a scientific daylight having a color temperature from 6200°C to 7200°C. Daytime color evaluation shall be illuminated at 45 degrees and viewed at 90 degrees. There shall be no significant color shift when viewed under nighttime (retroreflective) conditions.

The reflective sheeting shall have a pre-coated pressure sensitive adhesive (Class 1) or a heat-activated adhesive (Class 2) either of which will adhere to flat, clean surfaces without necessity of additional adhesive coats on the reflective sheeting or application surface. Chemical activators shall not be used to activate Class 2 adhesive. The pre-coated adhesive shall be protected by an easily removed liner which, when removed, shall not have a staining effect on the reflective sheeting and shall be mildew resistant. The protective liner attached to the adhesive shall be removable by peeling without soaking in water or other solvents and shall be easily removed after storage for 4 hours at 65°C under 17 kilopascals. The sheeting with liner removed, conditioned for 24 hours at 22°C and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 3-millimeter diameter mandrel with the adhesive side contacting the mandrel. For ease of testing, talcum powder my be spread on the adhesive to prevent sticking to the mandrel. The sheeting surface shall be smooth and flat to facilitate self-cleaning in the rain, regular cleaning, and wet performance, and exhibit 85 degrees glossmeter rating of not less than 50 when tested in accordance with ASTM D 523. The sheeting surface shall be readily processed and compatible with transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application. The sheeting shall permit cutting and color processing at temperatures of 15°C to 38°C and 20 to 80 percent RH. The sheeting shall be heat resistant and permit force curing without staining of unapplied sheeting or applied sheeting at temperatures recommended by the manufacturer not to exceed 65°C for unapplied sheeting or 93°C for applied sheeting. The sheeting surface shall be solvent resistant to permit cleaning by wiping with a clean soft cloth dampened with VM&P Naphtha or mineral spirits.

The adhesive shall form a durable bond to smooth, corrosion and weather resistant surfaces and permit the reflective sheeting to adhere securely, 48 hours after application at temperatures of -35°C to 93°C. The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when subjected to an impact energy of 27 newton meters applied with a hemispherical tipped object 25 millimeters in diameter at -18°C. The test specimen shall be applied to aluminum backing not less than 2 millimeters thick and having a dimension of not less than 100 millimeters square. During testing, the specimen shall be supported on a 75-millimeter diameter ring.

The adhesion test shall conform to ASTM D 4956 with the addition of the temperatures noted above.

The resistance to accelerated weathering shall be as described in ASTM D 4956 except the weathering apparatus and procedure shall be in accordance with ASTM G 53.

The reflective sheeting shall be sufficiently flexible to be cut to shape easily and permit application over, and conform to, moderate shallow embossing characteristic of certain sign borders and symbols. The tensile strength of the sheeting shall be 0.9 to 3.5 newtons per millimeter width when conditioned for 48 hours in accordance to ASTM D 685 and tested in accordance with ASTM D 828. Following liner removal, the reflective sheeting shall not shrink more than 0.8 millimeter in ten minutes nor more than 3 millimeters in 24 hours in any dimension per 230 millimeters square at 24°C and 50 percent relative humidity.

The sheeting, when applied according to manufacturer's recommendations to cleaned and etched 0.5-millimeter × 50-millimeter x 200-millimeter aluminum, conditioned (24 hours) and tested at 22°C and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 19-millimeter diameter mandrel.

9-28.12(1) Application

The reflective sheeting shall be applied in the manner specified by the sheeting manufacturer. The applied sign face shall not have bubbles, wrinkles, or foreign material beneath the reflective sheeting.

9-28.12(2) Edge Treatment

All edges and splices of reflective sheeting signs shall be coated with an edge sealer when recommended by the manufacturer of the reflectorized sheeting.

9-28.12(3) Splices and Color Matching

Splicing of reflective sheeting shall not be permitted on signs or panels with dimensions up to and including 1200 millimeters in height or width unless the reflective sheeting specified does not come in this width, then the widest width material shall be used. When sheeting joints are required, they shall be lap-jointed with the top sheet overlapping the bottom sheet by no less than 5 millimeters. The fabricator shall endeavor to use the least number of seams possible with the horizontal lap preferable. Roller applied or reverse screened sheeting may be butt-jointed with joint gap not to exceed 1 millimeter. Color matching of adjacent sheets of reflective sheeting comprising a sign shall be accomplished without a noticeable difference in color. No borders shall be spliced other than the splice of the tangent border to the corner radius.

9-28.13 Demountable Prismatic Reflectorized Message and Borders

The letters, digits, and alphabet accessories shall consist of embossed 1-millimeter thick sheet aluminum frames conforming to ASTM B 209M grade 3003-H14 in which prismatic reflectors are installed to prevent their displacement in handling or service. Letters in which reflectors are assembled by means of tape are unacceptable. The plastic reflectors face shall be colorless and be entirely smooth to present a water repellent and dirt resistant surface. The area indicating the letter shape that is not reflectorized shall be white for maximum daytime contrast with the sign background. All letters shall be free of any imperfections and shall present a high quality appearance. Demountable prismatic border shall be comprised of a minimum length of 600 millimeters with allowance of one shorter section between each corner radius.

Letters shall be fastened to the sign with aluminum screws or blind rivets conforming to ASTM B 209M grade 2024-T4.

The coefficient of retroreflection of each reflex reflector intended for use in cutout letters, symbols, and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

Observation Angle (degrees)	Entrance Angle (degrees)	Coefficient of Retroreflection Candela/Lux/Square Meter
0.1	0	2000
0.1	20	800

Failure to meet the specific minimum values shall constitute failure of the reflector being used. Upon failure of more than two of the 50 samples tested, a resample of 100 reflectors shall be tested. Failure of more than four of these samples shall be cause for rejection of the lot.

9-28.14 Sign Support Structures

All sign support structures shall be constructed as shown in the Plans.

9-28.14(1) Timber Sign Posts

At the Contractor's options, timber sign posts and mileposts shall be untreated Western cedar, treated Douglas fir, or treated Hem-fir meeting the grades specified in Section 9-09.2. Douglas fir and Hem-fir posts shall be given a treatment in accordance with Section 9-09.3(1). Preservative retention shall be a minimum of 6.4 kilograms per cubic meter. Penetration shall be a minimum of 10 millimeters or 90 percent of sapwood for posts under 125 millimeters thick and 13 millimeters or 90 percent of sapwood for posts 125 millimeters or thicker. S4S finish is not required for unpainted posts.

9-28.14(2) Steel Structures and Posts

Anchor rods and washers for sign bridge and cantilever sign structure foundations shall conform to Section 9-06.5(4). Anchor rods shall be galvanized after fabrication a minimum of 305 millimeters on both ends in accordance with AASHTO M 232. Nuts and washers shall be galvanized after fabrication in accordance with AASHTO M 232. Anchor rod templates shall conform to AASHTO M 183M, and shall be galvanized after fabrication in accordance with AASHTO M 111.

Steel sign structures and posts shall be galvanized after fabrication in accordance with AASHTO M 111, unless noted otherwise in the Plans. All bolts, nuts, and washers shall be galvanized after fabrication in accordance with AASHTO M 232. Unless otherwise specified in the Plans or Special Provisions, metal surfaces shall not be painted.

Minor fabricating and modifications necessary for galvanizing will be allowed if not detrimental to the end product as determined by the Engineer. If such modifications are contemplated, the Contractor shall submit to the Engineer, for approval, six copies of the proposed modifications, prior to fabrication.

9-28.14(3) Aluminum Structures

Welding of aluminum shall be in accordance with Section 1.5 of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals," AASHTO 1994.

Aluminum materials shall conform to ASTM B 209M grades as follows: the filler alloy shall be 4043, 5365, or 5556 for welding base metals 6061 or 6063 to 6061, 6063, 356, or A356. Filler alloy for welding base metal 5086 shall be 5356 or 5556.

9-28.15 Sign Lighting Luminaires

Sign lighting luminaires shall have a cast aluminum housing and door assembly with a polyester paint finish. All external bolts, screws, hinges, hinge pins, and door closure mechanisms shall be series 300 grade stainless steel.

The housing shall encase a reflector, lamp socket, and ballast. It shall have a front entry (the side facing the sign) suitable for 13-millimeter conduit and mounting holes for attaching to a fixture mounting plate. Any additional enties shall have suitable plugs. The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the plans. If the sign structure includes a maintenance walkway, the luminaire fixture mounting plate shall be bolted to the walkway grating. Condensation drain holes shall be provided as recommended by the manufacturer.

The door shall be hinged to the housing on the side of the fixture away from the sign panel and shall be provided with two captive closure devices. The door shall be provided with the means to allow the door to be locked in the open position 70 to 90 degrees from the plane of the door opening. The juncture of the door and housing shall be gasketed to provide a rain tight and dust tight joint.

Refractors shall be manufactured from heat resistant borosilicate glass. The refractor shall be shielded so that no light source is visible from the sign viewing approach. The shield shall be an integral part of the door assembly. When called for in the plans, fixtures shall be provided with a wire guard to prevent damage to the refractor.

The reflector shall be manufactured from one piece polished (Alzak or equal) aluminum. The reflector shall be designed so condensed water will drain away.

The light source shall be a 175 watt deluxe phosphor coated mercury vapor lamp. The lamp socket shall be a porcelain enclosed mogul type containing integral lamp grips to ensure electrical contact under conditions of normal vibration. The center contact shall be spring loaded. The shell and center contact shall be rated for 1500 watts, 600 volts.

Ballasts shall be suitable for operating a 175 watt metal halide lamp and shall conform to the requirements of Section 9-29.9. The crest factor shall remain within a range of 1.6 to 1.8. Ballasts shall have a design life of no less than 100,000 hours.

Ballasts shall consist of separate components, each of which shall be capable of being easily replaced. All conductor terminals shall be identified as to the component terminal to which they connect. Heat generating components shall be mounted to use the portion of fixture on which they are mounted as a heat sink. Capacitors shall be separated from heat generating components or thermally shielded to limit the case temperature to 90°C. Each fixture shall be provided with a fusible terminal block. Fuses shall be 10 amp, 250 volt for 120 volt circuits, and 5 amp, 600 volt for 240 and 480 volt circuits. The primary voltage shall be as indicated in the plans. Photometric performance shall be as follows:

The ratio of the maximum to minimum illuminance level on a panel 3000 millimeters high by 4800 millimeters wide shall not numerically exceed 5:1 approaching 1:1. In addition, the illuminance gradient shall not numerically exceed 2:1, illuminance gradient being defined as the ratio of the minimum illuminance of a square panel 300 millimeters on a side to that of any adjacent panel of the same size. This performance shall be obtained when the fixture is mounted 300 millimeters below the bottom edge of the sign and 1500 millimeters out.

The average to minimum uniformity ratio for a panel as dimensioned above shall not numerically exceed 3:1. Average initial illuminance shall exceed 110 lux for a mercury vapor lamp of 175 watts as specified.

9-29 ILLUMINATION, SIGNALS, ELECTRICAL

9-29.1 Conduit

Rigid metal conduit shall conform to Article 346 of the National Electrical Code. PVC conduit shall conform to Article 347 of the National Electrical Code and to NEMA specification TC-2 (Conduit), TC-3 (Fittings-UL 514), and UL 651 (standard for rigid nonmetallic conduit). Fiberglass conduit and fittings shall be UL listed and shall comply with ANSI/NEMA standards TC-14A (filament wound reinforced thermosetting resin conduit and fittings) and ASTM D-2996.

Exterior and interior surfaces of all steel conduit, except threaded ends, shall be uniformly and adequately zinc coated by a hot-dip galvanizing process. The average mass of zinc coating shall be not less than 244 grams of zinc per square meter of single surface area as determined by tests on 300-millimeter samples taken from each end of a standard length of conduit of each size. The mass of zinc coating on any individual test specifications shall be not less than 214 grams of zinc per square meter of single surface area. The mass of zinc coating will be determined in accordance with AASHTO T 65. Determinations and nominal masses shall conform to the requirements of the Underwriters Laboratory Publication No. 6 (latest edition). In addition, the exterior as well as the interior conduit samples shall withstand four dips in the PREECE test in accordance with ASTM A 239. The threaded ends of all conduits shall be either galvanized in accordance with the foregoing or shall be painted with galvanized repair paint, Formula A-9-73. All field cuts shall also be painted with galvanized repair paint, Formula A-9-73.

Couplings for rigid metal type conduits may be either hot-dip or electroplated galvanized and, in addition, shall be painted with one coat of galvanizing repair paint Formula A-9-73. The paint shall have a minimum wet film thickness of 75 micrometers. The painted coating shall cover the entire coupling.

Grounding end bushings shall be galvanized malleable iron with copper, tinned copper, stainless steel, or integral lugs and stainless steel clamping screw, mounting screw, and set screw.

Every length of rigid metal conduit shall bear the label of Underwriters Laboratories, Inc. or the label of the Canadian Standards Association if affected items of Canadian manufacture are approved for use on the project. Installation shall conform to appropriate articles of the Code.

The colloidal copper compound required for coating threads on metallic conduit, couplings, and fittings shall consist of approximately 70 percent by mass of petroleum oil and 30 percent by mass of copper flakes.

9-29.2 Junction Boxes

Junction boxes shall conform to the requirements set forth in the contract. Concrete junction boxes shall have a compressive strength of 42 Mpa when unreinforced, and 28 Mpa when reinforced with 150 x 150 - W3 x W3 welded wire fabric, welded to the frame. Non-concrete junction boxes may be submitted for approval provided they have been designed to accommodate an AASHTO H - 20 Load. Junction boxes installed in concrete structures shall be of cast galvanized ferrous, NEMA 3 and 5 construction. A 10-millimeter drain shall be installed in each metallic junction box.

9-29.3 Conductors, Cable

For the purpose of this specification, the neutral conductor is defined as a current carrying conductor with zero potential. For the purpose of this specification, equipment grounding conductor is defined as the conductor used to connect the noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or the grounding electrode conductor at the service equipment or at the source of a separately derived system.

Conductors and cable shall conform to the applicable specifications as follows:

1. All current carrying single conductors shall be stranded copper conforming to ASTM B3 and B8. Insulation shall be 600 volt. Except as allowed in item 3, chemically cross-linked polyethylene or EPR Type USE insulation of code thickness is required for all current carrying single conductors in underground electrical systems. Equipment grounding conductors and bonding jumpers shall be stranded or solid copper wire the size noted on the Standard Plan for grounding details. Equipment grounding conductors may be bare or insulated, stranded or solid. When pulled through a raceway it shall be insulated with Type XHHW or Type THWN and shall have continuous green color or green color with one or more yellow stripes. Insulated equipment grounding conductors shall be stranded copper.
2. Two and three control conductor control cable shall consist of three No. 14 stranded copper conductors. Each conductor shall have 500-micrometer polyethylene insulation and a 250-micrometer PVC jacket. The cable shall be rated at 600 volts minimum. The cable assembly shall be covered with a polyester tape applied with a 10 percent minimum lap. The overall jacket shall be 1.1-millimeter PVC.

   Four conductor through 10 conductor signal control cable shall conform to International Municipal Signal Association (IMSA) signal cable specification 20-1 except the conductor sequence color code as shown in the following table. IMSA specification cables shall use No. 14 AWG stranded copper conductors. Individual conductors shall be cabled together in accordance with the following:

Conductor Number	Color Code	Color/Trace	Use
1	R	Red	Red or Don't Walk
2	O	Orange	Yellow or Spare
3	G	Green	Green or Walk
4	B	Black	Ped Call or Spare
5	W	White	Neutral
6	Wb	White/Black	Neutral or Spare
7	Bl	Blue	Ped Call or Spare
8	Rb	Red/Black	Red or Don't Walk
9	Ob	Orange/Black	Yellow or Spare
10	Gb	Green/Black	Green or Walk

3. All single conductors employed in traffic control shall be Class B or Class C stranded copper. The minimum wire size shall be No. 12 AWG. Insulation shall be THW or USE.

4. Triplex or Quadraplex type ACSR neutral self-supporting aerial conductors of the appropriate size for aluminum conductors shall be used where required in the contract. The neutral conductor shall be the same size as the insulated conductor. All current carrying conductors shall be stranded.
5. Pole and bracket cable shall be two conductor stranded copper No. 10 AWG insulated for 600 volts between conductors. The insulation shall consist of 1.1-millimeter polyvinyl chloride with 2.4-millimeter polyethylene jacket. If luminaires with remote ballasts are specified in the contract, this same cable shall be used between luminaire and ballast for both timber and ornamental pole construction. If the luminaire requires fixture wire temperature greater than 75°C, the outer jacket shall be stripped for that portion of the cable inside the luminaire. The single conductors shall then be sheathed with braided fiberglass sleeving of the temperature rating recommended by the luminaire manufacturer.
6. With the exception of type XHHW insulation and with the further exception of the shielded two conductor cable identified in (7), and the magnetometer lead-in cable identified in (9), the minimum insulation thickness around any electrical conductor shall be 1.1 millimeters, and the minimum acceptable insulation thickness shall refer solely to the thickness of that insulation immediately around any conductor excluding any sheath or jacket thickness.
7. Two conductor shielded cable shall have No. 14 conductors and shall conform to I.M.S.A. specification No. 50-2.
8. Detector loop wire shall be No. 14 AWG stranded copper wire, Class B, with chemically cross-linked polyethylene type RHH-RHW insulation of code thickness.
9. Four conductor shielded cable (4CS) shall consist of a cable with four No. 18 AWG conductors with polypropylene insulation, an aluminized polyester shield, water blocking material in the cable interstices, and a 660-micrometer minimum outer jacket of polyethylene. The four-conductor assembly shall be twisted 20 turns per meter. Each conductor shall have a different insulation color. Overall cable diameter shall be 6.35 millimeters maximum. Capacitance between adjacent pairs shall be 59 pf per meter and 49 pf per meter between diagonal pairs. The capacitances shall not vary more than 10 percent after a 10-day immersion test with ends exposed in a saturated brine solution.
10. Three-conductor shielded cable (3CS) for the detector circuit for optical fire preemption receivers shall consist of three No. 20 AWG conductors with aluminized mylar shield and one No. 20 drain wire, all enclosed with an outer jacket. All wires shall be 7 × 28 stranded tinned copper material. Conductor insulation shall be rated 75°C, 600 volt. The drain wire shall be uninsulated. Conductor color coding shall be yellow, blue, and orange. DC resistance of any conductor or drain wire shall not exceed 36 ohms per 100 meters. Capacitance from one conductor to the other two conductors and shield shall not exceed 157 pf per meter. The jacket shall be rated 80 C, 600 volt, with a minimum average wall thickness of 1.14 millimeters. The finished outside diameter of the cable shall be 7.6 millimeters maximum.
11. Six pair communications cable (6PCC) shall meet REA specification PE-39 and shall have six pair No. 19 AWG wires with 0.2-millimeter FPA/MPR coated aluminum shielding. The cable shall have a petroleum compound completely filling the inside of the cable.

9-29.4 Messenger Cable, Fittings

Messenger cable shall be 9.5-millimeter, 7-wire strand messenger cables conforming to ASTM A 475, extra-high-strength grade, 68.5 kilonewtons minimum breaking strength, Class A galvanized.

Strain insulators shall be wet process, porcelain, conforming to EEI-NEMA Class 54-2 standards for 53 kilonewtons ultimate strength.

Down guy assembly shall consist of a four-way or eight-way steel expanding anchor, having a minimum area of 0.19 square meter, made of pressed steel, coated with asphalt or similar preservative, and fitted with a 19-millimeter minimum guy eye anchor rod 2.4 meters long. As an alternate to expanding anchors, screw type anchors with two 200-millimeter helix, 89 millimeter pitch, 25-millimeter by 2.1-meter guy anchor rod, and rated for 31 kilonewtons maximum torque may be installed.

All pole hardware, bolts, plate rods, hangers, clips, wire guards, and pole bands shall be hot-dipped galvanized in conformance with the requirements of AASHTO M 232.

9-29.5 Pole Line Hardware

All miscellaneous pole line hardware shall be standard material manufactured for pole line construction. All metal parts shall be hot-dipped galvanized.

In addition to the above, whenever secondary racks are required, they shall be as classified "Heavy Service Secondary Rack" by the EEI-NEMA, and shall have a minimum spacing of 300 millimeters between the insulators. Each rack shall be secured to the pole by not less than one through bolt and one lag bolt.

Ground clamps shall be bronze.

9-29.6 Light and Signal Standards

Light and signal standards shall be in accordance with the details shown in the Plans, as specified in the Special Provisions and as outlined herein, provided that only one type of light or signal standard shall be used throughout the project.

Galvanized steel light or signal standards shall not be painted.

9-29.6(1) Steel Light and Signal Standards

Steel plates and shapes for light and signal standards shall conform to the requirements of AASHTO M 183M. Shafts for light and signal standards, except Type PPB signal standards, shall conform to AASHTO M 223M, Grade 345. Shafts and caps for Type PPB signal standards, slipfitters for type PS, I, FB, and RM signal standards, and all pipes shall conform to ASTM A 53, Grade B. Base plates for light standards shall conform to AASHTO M 223M, Grade 345, except as otherwise noted in the Standard plans for fixed base light standards. Base plates for signal standards shall conform to AASHTO M 183M. Connecting bolts shall conform to AASHTO M 164M. Fasteners for handhole covers, bands on lighting brackets, and conductor attachment brackets shall conform to ASTM F 593.

Light and signal standards shall be hot-dipped galvanized in accordance with AASHTO M 111 and AASHTO M 232.

9-29.6(1)A Vacant

9-29.6(2) Slip Base Hardware

Slip plates and anchor plates for light standards and for Type FB and RM signal standards shall conform to the requirements of AASHTO M 223M, Grade 345. The keeper plate shall be 28 gage, conforming to ASTM A 526M, coating G 90. Clamping bolts for slip

base assemblies and slip base adapters shall conform to AASHTO M 164M. Studs and bolts for slip base adapters shall conform to AASHTO M 164M. Nuts shall conform to AASHTO M 291M, Grade 10S. Hardened washers shall conform to AASHTO M 293. Plate washers shall conform to AASHTO M 183M.

9-29.6(3) Timber Light Standards, Timber Strain Poles, Timber Service Supports

All timber poles used in illumination or traffic signal systems shall be Douglas fir, machine shaved, roof sawed, conforming to the latest ANSI Specifications and Dimensions for Wood Poles.

All timber poles shall be gained according to industry standards. A dated nail or metallic date plate shall be set in the gain evidencing the year of treatment of the timber pole.

All poles shall be treated with pentachlorophenol in accordance with Section 9-09.3(1). Tops shall be sawed before treatment. Where holes are bored in poles to accommodate hanging bolts for brackets, transformers, guy assemblies, or other accessories, such holes shall be painted with a solution of the above preservative.

9-29.6(4) Welding

Welding of steel structures shall be in accordance with Section 1.4.2 of the Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals, AASHTO 1994.

9-29.6(5) Foundation Hardware

Anchor bolts for Type PPB, PS, I, FB, and RM signal standards shall conform to the requirements of ASTM A 307. Nuts shall meet the requirements of AASHTO M 291M. Washers shall meet the requirements of ASTM F 844.

Anchor bolts for Type II, III, IV, and V signal standards and luminaire poles shall meet the requirements of ASTM A 449 or AASHTO M 164M. Nuts shall be heavy hex meeting the requirements of AASHTO M 291, Grade C, D, or DH or AASHTO M 291M Class 8S or 10S. Washers shall meet the requirements of AASHTO M 293 or AASHTO M 293M.

All foundation hardware shall be hot-dipped galvanized in accordance with AASHTO M 111 and AASHTO M 232. Galvanized bolts shall be tested for embrittlement in accordance with ASTM A 143 or AASHTO M 203M.

9-29.7 Luminaire Fusing and Electrical Connections at Light Standard Bases

Electrical disconnects shall be installed in the base of every standard supporting a luminaire. Every conductor above ground potential shall be served by a fused quick-disconnect kit. Every conductor at ground potential shall be served by an unfused quick-disconnect kit.

Unfused quick-disconnect connectors shall conform to the following requirements.

1. A copper pin and a copper receptacle both of at least 90 percent conductivity shall be crimped to the cable. The receptacle shall establish contact pressure with the pin through the use of a copper beryllium sleeve spring and shall be equipped with a disposable mounting pin. The pin shall be of at least half-hard material and the crimping portion shall be fully annealed while the rest of the pin is maintained in its original state of hardness. The receptacle shall be fully annealed. Both the copper pin and receptacle shall have a centrally located recessed locking area adapted to be complementarily filled and retained by the rubber housing.

2. A plug and a receptacle housing shall be made of water resistant synthetic rubber which is capable of burial in the ground or installation in sunlight. Each housing shall provide a section to form a water-seal around the cable, have an interior arrangement to suitably and complementarily receive and retain the copper pin or receptacle, and a section to provide a water-seal between the two housings at the point of disconnection.

Fused quick-disconnect kits shall provide waterproof in-line fuse protection. The kit shall provide three cutoff sections on both lines and load side to accommodate various wire sizes. All connections shall be made with compression fittings. Upon disconnect, the fuse shall remain in the load side of the kit.

Fuses furnished for all lighting circuits shall be capable of handling the operating voltage of the circuit involved and shall have the following characteristics:

1. Fuses shall be capable of indefinitely supporting 110 percent of the rated load.
2. Fuses shall be capable of supporting 135 percent of the rated load for approximately 1 hour.
3. A load of 200 percent of rated load shall effectively cause instantaneous blowing of the fuse.
4. Fuses shall be rated as listed below and shall be sized to fit the fuse containers furnished on this project, according to the manufacturer's recommendations therefor.

Luminaire Size	Service Voltage 480V	240V	120V
1,000W	10A	15A	30A
750W	5A	10A	20A
700W	5A	10A	20A
400W	5A	10A	15A
310W	5A	5A	10A
250W	5A	5A	10A
200W	4A	5A	10A
175W	4A	5A	10A
150W	3A	4A	5A
100W	2A	3A	4A
70W	2A	2A	2A
50W	2A	2A	2A

5. Fuses shall be UL Listed.

9-29.8 Vacant

9-29.9 Ballast, Transformers

Ballast for high pressure sodium vapor lamps shall be designed to properly operate the lamp specified. Ballasts for high pressure sodium vapor lamps except 1,000 watt lamps shall be of the magnetic regulator type providing for a plus or minus 10 percent input voltage range with plus or minus 9 percent lamp watts regulation. 1,000 watt high pressure sodium lamps will be served by auto regulator type ballasts providing for a plus or minus 10 percent input voltage range with plus or minus 15 percent lamp watts regulation.

Ballasts for mercury vapor lamps shall be designed to properly operate the lamp specified. Ballasts shall be designed to start lamps at temperatures as low as -29°C. Ballasts shall have the electrical characteristics of the "constant wattage" or "regulator" type, high power factor with voltage ratings as noted in the plans. Mercury vapor ballasts shall be capable of plus or minus 2 percent lamp wattage regulation with plus or minus 13 percent input voltage variation.

Ballasts for metal halide lamps shall be designed to properly operate the lamp specified. Ballasts for all metal halide lamps shall be auto regulator type.

No capacitor, transformer, or other device shall employ the class of compounds identified as polychlorinated biphenyls (PCB) as dielectrics, coolants, or for any other purpose.

The power delivered to a lamp shall be limited to plus or minus 7.5 percent of the rated lamp power during normal operation and with a center rated lamp. During warm-up of the lamp, lesser power delivery will be permitted.

The power factor for all high pressure sodium vapor ballasts shall be 95 percent (nominal) or higher.

Each ballast shall have a name plate attached permanently to the case listing all electrical data.

9-29.10 Luminaires

All luminaires shall be of the distribution type and wattage indicated in the Plans. Clear lamps shall be employed unless indicated otherwise in the contract.

Conventional highway luminaires shall be ballast in-head type with cobra head configuration. Luminaire distribution types shall conform to the IES classification system. Conventional highway luminaires shall provide a cut-off distribution using a refractor-less housing and a high pressure sodium light source. The refactor shall not extend below the housing and shall not allow any light output above 90 degrees nadir. They shall be capable of accepting a 200, 250, 310, or 400 watt lamp complete with ballast.

All luminaires shall have a cast aluminum housing with a slip-fitter end mounting.

Horizontal luminaires shall attach to 50-millimeter pipe tenons on mast arms. Vertical mounted luminaires shall be appropriately sized for their respective pole top tenons. The reflector of all luminaires shall be of a snap-on design or shall be secured with screws. The reflector shall be manufactured of polished aluminum or molded from prismatically formed borosilicate glass. The refractor or flat lens shall be mounted in a door frame assembly which shall be hinged to the luminaire and secured in the closed position to the luminaire by means of an automatic type latch. The refractor or flat lens and door frame assembly, when closed, shall exert pressure against a gasket seat. Gaskets shall be composed of material capable of withstanding temperatures involved and shall be securely held in place.

All luminaires shall have their internal components secured to the luminaire frame with stainless steel mounting hardware (nuts, bolts, washers, hinges, etc.). The stainless steel shall be AISI, 300 series, chrome-nickel grade. The luminaire slip-fitter bolts shall be either stainless steel or hot-dip galvanized. The housing, complete with integral ballast, shall be weathertight.

The socket mounting mechanism shall be sufficiently rigid that upon application of a 9-newton load in any direction on the light source center, the light source center will not deflect more than 2 millimeters.

If sand-cast, the aluminum will be left in its natural finish, or, if die-cast, the aluminum shall receive a painted aluminum finish. All luminaires shall be mounted level, both transverse and longitudinally, as measured across points specified by the manufacturer. Leveling and orientation shall be accomplished after pole plumbing. Highway and decorative luminaires shall have slip-fitters capable of adjusting through a 5-degree axis for the required leveling procedure.

Refractors shall be formed from heat resistant, high impact, molded borosilicate glass. Flat lens shall be formed from heat resistant, high impact borosilicate or tempered glass.

The temperature rating of all wiring internal to the luminaire housing, excluding the pole and bracket cable, shall equal or exceed 90°C.

All luminaires shall be provided with markers for positive identification of light source type and wattage. Markers shall be 75 millimeters square with Gothic bold, black 50-millimeter legend on colored background. Background color shall be gold for sodium, blue for mercury, and red for metal halide light sources. Legends shall be sealed with transparent film resistant to dust, weather, and ultraviolet exposure. Legends shall correspond to the following code:

Lamp Wattage	Legend
70	7
100	10
150	15
175	17
200	20
250	25
310	31
400	40
700	70
750	75
1,000	XI

9-29.11 Control Equipment

Unless specified otherwise, illumination circuits shall be controlled by a combination of photoelectric controls and lighting contactors as noted in the contract.

9-29.11(1) Time Clock Controls

Time clocks, when specified in the contract, shall be solid state and shall have a battery backup. The clock shall provide four functions and shall be enclosed within a dust tight mounting case. The unit shall be mounted on vibration dampened fittings.

The unit shall be push button programmable with 15 events per week, selectable by day of week and time of day to the nearest minute.

The clock shall be accurate to plus or minus 15 seconds per month through a humidity variation of 0 to 95 percent and a temperature variation of -20°C to 65°C. The clock shall be within plus or minus 10 seconds after 10 hours of battery backup operation. The backup battery shall operate for 24 hours minimum.

Contacts shall be rated at 5 amps tungsten load for up to 100,000 cycles. Each clock function shall operate a 120 VAC normally open and normally closed set of contacts.

9-29.11(2) Photoelectric Controls

The photoelectric control shall be the twistlock type and the light sensitive element shall be a solid state photo diode. The control shall be designed to turn on at 32 lux and turn off at 20 lux. The lighting control shall not drift by more than 1 percent over a 10-year period.

The output control relay shall have a 45-second time delay to prevent false turn-off caused by momentary brightness. This output relay shall be rated 1,000 watts incandescent or 15 amps inductive load. The contacts shall be normally closed.

The lighting control shall have a built in metal oxide varistor (MOV) rated 320 joules for lightning and transient protection. The control shall also have secondary zener diode and transient filter. The printed circuit board shall be coated to prevent corrosion. The normal operating voltage range will be 105 to 285 VAC.

9-29.12 Electrical Splice Materials

Splicing in illumination circuits will be permitted only at junction boxes. With the exception of lead-in cable to loop wire or magnetometer sensing probe splices, no splices will be allowed in traffic signal circuitry. All other traffic signal circuitry will be terminated at a load, at control equipment, or at a terminal.

9-29.12(1) Illumination Circuit Splices

Splices and taps shall be made with solderless crimp connectors on underground circuits to securely join the wires both mechanically and electrically. Aerial splices may employ split bolt connectors. Cast splices at below grade locations shall employ epoxy resin cast type insulation. Two-way (in-line) splices and three-way (T or wye) splices shall employ clear rigid plastic molds. Clear mylar sheet bonded to butyrate webbing forming a flexible mold or heat shrink shall be used for four-way or more. The material used shall be compatible with the insulation material utilized. Equipment and methods shall be as recommended by the manufacturer of the splicing materials. The component materials of the resin insulation shall be packaged form ready for convenient mixing without removing from the package. Only one conductor or one multi conductor cable per wire entrance will be allowed in any rigid mold splice.

Heat shrink splices shall be manufactured from irradiated, crosslinked polyolefin suitable for direct burial installations and shall conform to requirements of ANSI C-119.1. The sealant shall be an approved stabilized mastic which shall provide a permanent moisture proof bond between the recovered polyolefin and any conductor insulating material.

9-29.12(2) Traffic Signal Splice Material

Induction loop splices and magnetometer splices shall be either epoxy resin cast type with clear rigid molds or re-enterable type with semi-hardening epoxy filling compound that remains semi-flexible enclosed in a re-enterable rigid mold with end cap seals.

9-29.13 Traffic Signal Controllers

A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

The Contractor shall furnish to the Contracting Agency all guarantees and warranties furnished as a normal trade practice for all control equipment that is provided.

9-29.13(1) Vacant

9-29.13(2) Flashing Operations

All controllers shall be equipped for flashing operation of signal displays. Controllers shall be programmed for flashing red displays for all approaches. During flash display all pedestrian circuits shall be de-energized.

Actuated traffic signal control mechanisms shall be capable of entry into flash operation and return to normal operation as follows:

1. Terminal Strip Input (Remote Flash). When called as a function of a terminal strip input, the controller shall provide both sequenced entry into flash and sequenced return to normal operation consistent with the requirements of the latest edition of the Manual on Uniform Traffic Control Devices.
2. Police Panel Switch. When the flash-automatic switch located behind the police panel door is turned to the flash position, the signals shall immediately revert to flash; however, the controller shall "STOP TIME." When the switch is placed on automatic, the signals shall continue to flash for an additional 8-second flash period. At the completion of the continued 8-second flash period, unless otherwise specified, the controller shall immediately resume normal cyclic operations at the beginning of artery green.
3. Controller Cabinet Switches. When the flash-automatic switch located inside the controller cabinet is placed in the flash position, the signals shall immediately revert to flash; however, the controller shall continue to function. When the flash-automatic switch is placed in the automatic position, the controller shall immediately resume normal cyclic operation at the beginning of the artery green. Adjacent to the flash-automatic switch shall be a controller on-off switch. If the flash-automatic switch is in the automatic position and the controller on-off switch is placed in the OFF position, the signals shall immediately revert to flash.
4. Power Interruption. On "NEMA" controllers any power interruption longer than 475 plus or minus 25 milliseconds, signals shall re-energize consistent with No. 2 above to ensure an 8-second flash period prior to the start of artery green. A power interruption of less than 475 plus or minus 25 milliseconds shall not cause resequencing of the controller and the signal displays shall re-energize without change. Type 170 controllers shall re-energize consistent with No. 2 above after a power interruption of 1.75 plus or minus 0.25 seconds. The 8-second flash period will not be required.
5. Conflict Monitor. Upon sensing conflicting signals or unsatisfactory operation voltages, the conflict monitor shall immediately cause the signal to revert to flash; however, the controller shall stop time at the point of conflict. After the conflict monitor has been reset, the controller shall immediately take command of the signal displays at the beginning of artery green.

9-29.13(3) Emergency Preemption

Immediately after a valid call has been received, the preemption controls shall cause the signals to display the required clearance intervals and subsequent preemption intervals. Preemption shall sequence as noted in the contract. Preemption equipment shall be installed so that internal wiring of the controller, as normally furnished by the manufacturer, is not altered. Termination of the preemption sequence shall place a call on all vehicle and pedestrian phases. Preemption indicators, if required, shall turn on when the controller reaches the preempted phase.

9-29.13(4) Wiring Diagrams

Schematic wiring diagrams of the controllers and auxiliary equipment shall be submitted at the time the controllers are delivered for testing or, if ordered by the Engineer, previous to purchase. The diagram shall show in detail all circuits and parts. The parts shall be identified by name or number in a manner readily interpreted.

9-29.13(5) Vacant

9-29.13(6) Radio Interference Suppressers

All traffic signal controllers, flashers, or other current-interrupting devices shall be equipped with radio interference suppressers installed at the input power point. Interference suppressers shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilocycles to 75 megacycles when used in connection with normal installations.

The interference filters furnished shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals shall be nickel plated, 10-24 brass studs of sufficient external length to provide space to connect two No. 8 AWG wires, and shall be so mounted that they cannot be turned in the case.

Ungrounded terminals shall be insulated from each other and shall maintain a surface leakage distance of not less than 6 millimeters between any exposed current conductor and any other metallic parts with an insulation factor of 100-200 megohms dependent on external circuit conditions.

Suppressers shall be designed for operations on 50 amperes, 125 volts, 60 cycles, single wire circuits, and shall meet standards of the Underwriters' Laboratories and the Radio Manufacturers Association.

9-29.13(7) Traffic-Actuated Controllers

Traffic-actuated controllers shall be electronic devices which, when connected to traffic detectors or other means of actuation, or both, shall operate the electrical traffic signal system at one or more intersections.

All solid-state electronic traffic-actuated controllers and their supplemental devices shall employ digital timing methods.

Type 170 control equipment shall conform to the California Department of Transportation document entitled "Traffic Signal Control Equipment Specifications," dated January 1989, including Addendum 8, dated November 19, 1993. NEMA control equipment shall conform to current NEMA specifications.

Actuated traffic signal controllers shall be 8-phase control units. Volume-density timing features shall be provided on all controllers.

Every pin of every connecting plug shall be utilized as described within the NEMA requirement, except that those pins identified as "spare" or "future" shall remain unused. Controller interchangeability between NEMA controllers of any and all approved makes is mandatory, and demonstration of interchangeability will be a portion of Olympia Service Center Materials Laboratory testing.

Overlaps for NEMA controllers may be accomplished by programming of software or by use of NEMA overlap boards. If a manufacturer elects to utilize the software method, they shall be required to furnish an overlap board with each signal controller which will allow substitution of controllers using the alternated method of overlaps.

NEMA controllers shall provide indications for vehicle call and pedestrian call that can be viewed simultaneously with indications for timing intervals. Controllers shall provide indications for timing intervals in both rings that can be viewed simultaneously. Reason for green termination shall be displayed simultaneously with other timing data.

All controllers shall provide a "simultaneous gap out" feature. This feature allows retiming a gap from a green rest upon an actuation.

9-29.13(7)A Environmental, Performance, and Test Standards for Solid-State Traffic Controllers

The scope of this specification includes the controller assembly of solid-state design installed on local intersections. The controller assembly includes the weather-proof cabinet, controller unit, load switches, signal conflict monitoring circuitry, accessory logic circuitry, AC line filters, vehicle detectors, coordination equipment and interface, and preemption equipment. The control assembly shall meet or exceed NEMA Environmental Standards and Test Procedures. Normal operation will be required while the control assembly is subjected to any combination of high and low environmental limits (i.e. low voltage at high temperature with high repetition noise transients).

9-29.13(7)B Auxiliary Equipment for Traffic Actuated Controllers

The following auxiliary equipment shall be furnished and installed in each cabinet for NEMA traffic-actuated controllers:

1. A solid-state Type 3 NEMA flasher with flash-transfer relay which will cut in the flasher and isolate the controller from light circuits. See Section 9-29.13(2) for operational requirements.
2. Solid-state load switches of sufficient number to provide for each vehicle phase (including future phases if shown in the plans), each pedestrian phase and preemption sequence indicated in the contract. Type P&R cabinets shall include a fully wired 16-position back panel. Solid-state load switches shall conform to NEMA standards except only optically isolated load switches will be allowed. Load switches shall include indicator lights on the input circuits.
3. A power panel with:
    a. A control-display breaker sized to provide 125 percent overload protection for all control equipment and signal displays, 30 ampere minimum.
    b. A 20 ampere accessory breaker wired parallel to the control-display breaker. The breaker will carry accessory loads, including vent fan, cabinet light, plug receptacle, etc.
    c. A busbar isolated from ground and unfused for the neutral side of power supply.
    d. A radio interference suppresser to the output side of the control-display breaker. See Section 9-29.13(6) for other requirements.
    e. A transient voltage protection device connected to the controller power circuit for protection against voltage abnormalities of 1 cycle or less duration. The protector shall be a solid state high energy circuit containing no spark gap, gas tube, or crow bar component. The current rating of the device shall be 15 amps minimum. The device shall provide transient protection between neutral and ground, line and ground, as well as line and neutral. If the protection circuits fail, they shall fail to an open circuit condition. The device shall meet all requirements of UL standard 1449. The suppressed voltage rating shall be 600 volts or less when subjected to an

impulse of 6,000 volts, 3,000 amp source impedance, 8.0/20 microsecond waveform as described in UL 1449. In addition, the device shall withstand, without failure or permanent damage, one full cycle at 264 volts RMS. The device shall contain circuitry to prevent self-induced regenerative ringing. There shall be a failure warning indictor light which shall illuminate when the device has failed and is no longer operable.

f. Cabinet ground busbar independent (150K ohms minimum) of neutral.

4. A police panel located behind the police panel door with a flash-automatic switch and a control-display power line on-off switch. See Section 9-29.13(2) for operational requirements.
5. An auxiliary control panel located inside the controller cabinet with a flash-automatic switch and a controller on-off switch. See Section 9-29.13(2) for operational requirements. A three wire 15 ampere plug receptacle with grounding contact and 20 ampere ground fault interrupter shall also be provided on the panel.
6. A conflict monitor conforming to NEMA standards. See Section 9-29.13(2) for operational requirements. The unit shall monitor conflicting signal indications at the field connection terminals. The unit shall be wired in a manner such that the signal will revert to flash if the conflict monitor is removed from service. Supplemental loads not to exceed 10 watts per monitored circuit or other means, shall be provided to prevent conflict monitor actuation caused by dimming or lamp burn-out. Supplemental loads shall be installed on the control side of the field terminals. Conflict monitors shall include a minimum of one indicator light for each phase used. The monitoring capacity of the unit shall be compatible with the controller frame size. Conflict monitors shall include a program card.
7. A “Display Panel” when noted in the contract. The display panel shall depict a generic eight-phase operation. The panel shall be mounted on the inside of the front cabinet door and the mounting shall be of a design that allows positioning of the panel in four orientations ninety degrees from each other. The mounting shall be removable without use of any tools. Incandescent red, yellow, green, walk and don’t walk indicator lights shall be provided for each phase. The indicator lights shall be connected to the associated field terminals. The connecting cable shall be long enough to allow for any mounting orientation. No diodes will be allowed in the display panel. A means of disconnecting all wiring entering the panel shall be provided. Switches shall be provided on the panel with labels and functions as follows:
   a. Display On — Signal indicator lamps will display the operation of the intersection.
   b. Test — All indicator lamps shall be energized.
   c. Display Off — all signal indicator lamps shall be de-energized.

   A. “Detector Panel”. The panel shall be mounted on the inside of the front cabinet door. The detector panel may be constructed as a single unit or it may be constructed as a combined unit with the “Display Panel” if a “Display Panel” is required in the contract. Detector switches with separate operate, test, and off positions shall be provided for each field detector input circuit. A high intensity light emitting diode (LED) shall be provided for each switch. The lamp shall energize upon vehicle, pedestrian or test switch actuation. The test switch shall provide a spring loaded momentary contact that will place a call into the controller. When in the OFF position, respective detector circuits will be

disconnected. In the operate position, each respective detector circuit shall operate normally. Switches shall be provided on the panel with labels and functions as follows:

a. Display On — Detector indicator lights shall operate consistent with their respective switches.
b. Display Off — detector indicator lights shall be de-energized.

A means of disconnecting all wiring entering the panel shall be provided. The disconnect shall include a means to jumper detection calls when the display panel is disconnected. All switches on the panel shall be marked with its associated plan detector number. All markers shall be permanent

8. Insulated terminal blocks of sufficient number to provide a termination for all field wiring. A minimum of 12 spare terminals shall be provided. Terminal blocks shall be 600 volt, heavy duty, barrier type, except loop detector lead-ins which may be 300 volt. Each terminal shall be provided with a field-side and a control-side connector separated by a marker strip. The marker strip shall bear the circuit number indicated in the plans and shall be engraved. Each connector shall be a screw type with No. 10 post capable of accepting no less than three No. 12 AWG wires fitted with spade tips.
9. A vent fan with adjustable thermostat. The minimum CFM rating of the fan shall exceed three times the cabinet volume.
10. An incandescent or fluorescent interior cabinet light mounted at the top of the enclosure with door switch to automatically energize when the door opens. The light shall be installed a minimum of 300 millimeters from the vent fan thermostat. The switch shall be labeled “light.”
11. All wiring within the cabinet, exclusive of wiring installed by the signal controller manufacturer, shall have insulation conforming to the requirements of Section 9-29.3. Cabinet wiring shall be trimmed to eliminate all slack and shall be laced or bound together with nylon wraps or equivalent. All terminals, exclusive of field terminals, shall be numbered and permanently identified consistent with the cabinet wiring diagram provided by the signal controller manufacturer. The cabinet will be completely wired so that the only requirement to make a field location completely operational is to attach field power and ground wiring. Internal cabinet wiring shall not utilize the field side connections of the terminal strip intended for termination of field wires.
12. One reproducible mylar or two microfilms and four copies of the cabinet wiring diagram and component wiring diagrams shall be furnished with each cabinet. Each cabinet shall be equipped with a plastic envelope to house one or more cabinet wiring diagrams. The cabinet wiring diagram shall indicate and identify all wire terminations, all plug connectors, and the locations of all equipment in the cabinet. Included in the diagram shall be an intersection sketch identifying all heads, detectors, and push buttons; and a signal sequence chart.
13. Each vehicle detector amplifier, pedestrian call isolation unit, phase selector, and load switch shall be identified with semi-permanent stick-on type label. The following information shall be included:
    a. Vehicle Detector Amplifier Channel
        1. Loop number
        2. Assigned phase(s)
    b. Ped Call Isolation Unit

1. Push button number
2. Assigned phase(s)

c. Load Switches
1. Signal head number
2. Assigned phase(s)

d. Phase Selectors
1. Circuit Letter
2. Phase(s) called

The label shall be placed on the face of the unit. It shall not block any switch, light, or operational words on the unit. The lettering on this label shall be neat, legible, and easily read from a distance of approximately 2 meters.

The following requirements apply to auxiliary equipment fumished with Type 170 controller cabinets:

Flashers, flash transfer relays, conflict monitor, AC isolators, DC isolators, discriminator modules, program modules, modem modules, load switches, breakers, buses, police panel switches, receptacle requirement, vent fan and auxiliary control panel switches shall confomm to the requirements noted in the Califomia Department of Transportation document entitled "Traffic Signal Control Equipment Specifications", specified in Section 9-29.13(7).

Flashing operation shall conform to Section 9-29.13(2), except the 8-second flash period described in Item 2 of that section will not be required. Emergency preemption shall conform to Section 9-29.13(3).

The requirements for radio interference suppresser, transient voltage protection, terminal blocks, cabinet light (florescent only), cabinet wiring, wiring diagram and equipment labeling are the same as previously noted for the NEMA control assemblies. Input and output terminals shall be installed with a marking strip with field wire numbers noted in the contract embossed on the strip. Supplemental load requirements to prevent conflict monitor actuation on lamp burn-out are the same as previously noted for NEMA control assemblies.

A "Display Panel" conforming to the requirements previously noted for the NEMA control assemblies shall be provided when noted in the contract.

A "Detection Panel" conforming to the requirements previously noted for the NEMA control assemblies shall be provided except the panel shall be a separate unit from the "Display Panel." The panel shall be rack mounted above the controller and shall conform to details in the contract.

A "Detector Termination and Interface Panel" shall be provided. When viewing the cabinet from the back, the panel shall be located on the upper left hand side of the cabinet. The panel shall be electrically located between the "Detector Panel" and the C-1 connector. The panel shall utilize insulated terminal blocks and each connector shall be a screw type with post.

A print holder roll-out drawer shall be provided. The drawer shall be rack mounted below the controller.

A "DB-9" socket shall be mounted on the rack facing the front door of the cabinet and shall be easily accessible when the front door is open. The socket shall provide a communication interface between a personal computer and the C-20S connector on the back of the controller. The appropriate cable and C-20 plug connector shall be part of this assembly to provide ease of connection to the controller.

A C-2 plug with 1.8 meters of 22 AWG 4 conductor shielded cable shall be provided in each cabinet. The cable shall be terminated on positions 3, 4, and 6 of the TB terminal block.

An "Absence Of Red Programming Assembly" shall be provided. There shall be provided on the back panel of the output file, 16 accessible jumper plug attachment areas, made up of three male pins per position (one set of three, for each conflict monitor channel). Each jumper plug shall be a three position Molex style connector, using crimped wire pins. Two female pins shall be installed in each jumper plug, one attached to each end of a single wire. These pins shall be installed in the connector, one on the center position and one in either outer position of the plug. It shall be possible, by inserting and positioning one of the 16 jumper plugs on the right two pins on the monitor board, to apply 120 VAC into a corresponding channel of the conflict monitor red channels. The connection between the absence of red programming board and the 210 plus conflict monitor shall be accomplished via a 20 pin ribbon cable and the industry standard P-20 connector, that attaches on the front panel of the monitor. It shall be possible, by inserting and positioning one of the 16 jumper plugs on the two left pins on the monitor board, to enable the red monitor on the corresponding channel (phase). There shall be installed on the absence of red programming assembly a red enable disconnect relay, that controls the 120 VAC red enable signal into the 210 plus monitor. During normal operation, the normally closed contacts of this relay shall supply 120 VAC into the red enable input of the monitor. When energized, this red enable signal shall be removed from the input disabling red monitoring. The relay shall be energized by the corresponding Cl pin connection, as required by the local software, to indicate that the assembly is in processor flash.

9-29.13(7)C Vacant

9-29.13(7)D Controller Cabinets

Each traffic-actuated NEMA controller shall be housed in a weatherproof cabinet conforming to the following requirements:

1. Construction shall be of 1.85-millimeter minimum thickness Type 304 stainless steel, 3.18-millimeter minimum thickness sheet aluminum, or cast aluminum. Cabinets shall be finished inside with an approved finish coat of exterior white enamel and outside with an approved enamel finish, light gray or aluminum in color. As an alternate to painting, the outside and inside of aluminum cabinets may be clear anodized.
2. The cabinet shall contain shelving, brackets, racks, etc., to support the controller and auxiliary equipment. All equipment shall set squarely on shelves or be mounted in racks and shall be removable without turning, tilting, or rotating or relocating one device to remove another.
3. The cabinet shall be of adequate size to properly house the controller and all required appurtenances and auxiliary equipment in an upright position with a clearance of at least 75 millimeters from the vent fan and filter to allow for proper air flow. In no case shall more than 70 percent of the cabinet volume be used. There shall be at least a 50 millimeter clearance between shelf mounted equipment and the cabinet wall or equipment mounted on the cabinet wall.
4. The cabinet shall have an air intake vent on the lower half of the main door, with a 300 millimeters by 400 millimeters by 25 millimeters removable throw-away filter, secured in place with a spring-loaded framework.

5. The cabinet door shall be provided with:
   a. A spring loaded construction core lock capable of accepting a Best CX series core installed by others. Cast cabinets shall have an approved one point positive latch. Formed cabinets shall have a three point latch.
   b. A police panel door with a stainless steel hinge pin and a lock. Two police keys with shafts a minimum of 45 millimeters long shall be provided with each cabinet.
   c. Both main door and police panel door shall have one piece, closed cell, neoprene gaskets.
   d. A two position door stop assembly.

Type 170 controllers shall be housed in a Model 332 cabinet conforming to the California Department of Transportation document entitled "Traffic Signal Control Equipment Specifications," specified in Section 9-29.13(7). The cabinet shall be constructed of aluminum and the surfaces shall be anodized. Each door shall be furnished with a construction core lock conforming to 5a above.

9-29.14 Vacant

9-29.15 Flashing Beacon Control

Flashers shall conform to the latest NEMA publication, and shall be solid state.

When used as a beacon control, they shall be jack mounted and installed in a raintight aluminum or galvanized sheet metal cabinet as noted in the contract.

9-29.16 Vehicular Signal Heads

Each signal head shall be of the adjustable, vertical type with the number and type of lights detailed in the contract; shall provide a light indication in one direction only; shall be adjustable through 360 degrees about a vertical axis; and shall be mounted at the location and in the manner shown in the plans. Except for optically programmed signal heads, all vehicular signal heads at any one intersection shall be of the same make and type.

9-29.16(1) Optically Programmed, Adjustable Face, 300-Millimeter Traffic Signal

The signal shall permit the visibility zone of the indication to be determined optically and require no hoods or louvers. The projected indication may be selectively visible or veiled anywhere within 15 degrees of the optical axis. No indication shall result from external illumination, nor shall one light unit illuminate a second.

9-29.16(1)A Optical System

The components of the optical system shall comprise:

1. Lamp,
2. Lamp Collar,
3. Optical Limiter-Diffuser, and
4. Objective Lens.

The lamp shall be nominal 150 watt, 120 volt AC, three prong, sealed beam having an integral reflector with stippled cover and an average rated life of at least 6,000 hours. The lamp shall be coupled to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter.

The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 275 to 365 meters distant, and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be provided with positive indexing means and composed of heat-resistant glass.

The objective lens shall be a high resolution planar incremental lens hermetically sealed within a flat laminant of weather resistant acrylic or approved equal. The lens shall be symmetrical in outline and may be rotated to any 90 degrees orientation about the optical axis without displacing the primary image.

The optical system shall accommodate projection of diverse, selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer after optically limiting procedures have been accomplished. The projected indication shall conform to ITE transmittance and chromaticity standards.

9-29.16(1)B Construction

Die cast aluminum parts shall conform to ITE alloy and tensile requirements and have a chromate preparatory treatment. The exterior of the signal case, lamp housing, and mounting flanges shall be finished with a high quality, baked enamel prime and finish paint. The lens holder and interior of the case shall be optical black.

Signal case and lens holder shall be predrilled for backplates and visors. Hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather resistant rubber gaskets.

Backplates shall conform to ITE material requirements and include a chromate preparatory treatment and optical black on all surfaces.

9-29.16(1)C Mounting

The signal shall mount to standard 40-millimeter fittings as a single section, as a multiple section face, or in combination with other signals. The signal section shall be provided with an adjustable connection that permits incremental tilting of at least 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting. Terminal connection shall permit external adjustment about the mounting axis in five degree increments. The signal shall be mountable with ordinary tools and capable of being serviced with no tools.

Attachments such as visors, backplates, or adapters shall conform and readily fasten to existing mounting surfaces without affecting water and light integrity of the signal.

9-29.16(1)D Electrical

The lamp fixture shall be comprised of a separately accessible housing and integral lamp support, indexed ceramic socket, and self-aligning, quick release lamp retainer. The electrical connection between case and lamphousing shall be accomplished with an interlock assembly which disconnects lamp holder when opened. Each signal section shall include a covered terminal block for clip or screw attachment of lead wires. Concealed No. 18 AWG-AWM, stranded and coded wires shall interconnect all sections to permit field connection within any section.

9-29.16(1)E Photo Controls

Each signal section shall include integral means for regulating its intensity between limits as a function of individual background illumination. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 10 700 lux ambient and shall reduce to 15 plus

or minus 2 percent of maximum at less than 10.7 lux ambient. Response shall be proportional and essentially instantaneous to any detectable increase of illumination from darkness to 10 700 lux ambient and damped for any decrease from 1070 lux ambient.

The intensity controller shall comprise an integrated, directional light, sensing and regulating device interposed between lamp and line wires. It shall be compatible with 60 Hz input and responsive within the range 105 to 135 v. Output may be phase controlled, but the device shall provide a nominal terminal impedance of 1,200 ohms open circuit and a corresponding holding current.

9-29.16(1)F Installation

The signal shall be installed, directed, and veiled in accordance with published instructions and the project visibility requirement. Each section of the signal shall be masked with prescribed materials in an acceptable and workmanlike manner.

9-29.16(2) Conventional Traffic Signal Heads

9-29.16(2)A Optical Units

Optical units for traffic signal displays shall conform to the requirements of ITE Publication No. ST-008B and the following:

1. Light emitting diode (LED) light sources are required for 300 mm red arrow displays. LED displays shall conform to the following:
   a. Wattage (Maximum): 15 watts
   b. Voltage: The operating voltages shall be between 85 VAC and 130 VAC.
   c. Temperature: Temperature range shall be –35°C to +75°C.
   d. LED Types: LEDs shall be Hewlett Packard HLMPC100 “LED” or equal in brightness and bulb life. LEDs shall be driven at no more than 50 percent of their rated amperage.
   e. LED Number: 250 minimum
   f. Circuit Configuration: LEDs shall be connected to form multiple series circuits, with a minimum of 3 circuits. All series circuits shall be interconnected at intervals forming subcircuits not exceeding 14 LEDs each. These subcircuits shall limit the number of extinguished LEDs to no more than 4 percent of the total on the display in the event of a single LED failure.
   g. Color and Light Intensity: Color and light intensity testing shall be conducted after 30 minutes of continuous operation.
   h. Enclosure: The enclosure for the LEDs and associated circuitry shall be dust and water resistant.
   i. Lens: The lens shall be clear “Hard Coated” polycarbonate (UV stabilized “Lexan”) convex lens with a minimum of 3.1 mm thickness. The light transmittance shall be 92 percent minimum. The lens shall be free from bubbles, flaws, and other imperfections. The lens shall not be diffused. The hard coating shall be tested as follow:

      Abrasion Test: Taber Abrasion Test (with 500g. Ioad on each wheel at 1000 cycles.) Haze % shall be measured per ASTM D 1003-6L. The change in Haze shall be between 3.0 and 7.0.

      Water Immersion Test: The lens shall be immersed in tap water at 6.5°C for 500 hours minimum and shall show no cracking or loss of adhesion.

QUV Exposure Test: The test shall be performed with a QUV instrument manufactured by Q Panel Corporation. The cycle shall be 8 hours UV at 70°C and 4 hours cond. Humidity at 50°C. After 500 hours the yellowness index shall be between 1 and 4. After 800 hours sunlamp exposure there shall be no cracking or loss of adhesion.

j. Printed Circuit Boards: The printed circuit boards shall have conformal coating with acrylic resin base coating. "Loctite Shadow Cure" (Item 18893) or equivalent.
k. Dimming: The unit shall be capable of accepting half wave AC power.
l. Options: The unit shall be capable of accepting a lens with increased thlckness.
m. Prior Experience: Each model type submitted for approval shall have a minimum of 6 months actual field experience as part of documented test program administered by a public agency.
n. Warranty: A five-year written manufacturer's warranty from date of installation on parts and materials will be required.
o. Label: A label shall be provided on the LED housing. The Contractor shall mark the label with a permanent marker to note the installation date.

2. Three hundred millimeter red ball, yellow ball, yellow arrow, green ball and green arrow displays and 200 millimeter red ball, yellow ball and green ball displays shall use incandescent light sources and shall conform to the following.

a.	Light Source:	200 mm	Clear Bulb, A21/TS with medium base.
		300 mm	Clear bulb, P25/TS with medium base.
b.	Voltage: 120 VAC		
c.	Rated Initial Lumens at 120 VAC:	200 mm	595
		300 mm	1750
d.	Minimum Initial Lumens at 120 VAC:	200 mm	550
		300 mm	1650
e.	Light Center:	200 mm	62 mm
		300mm	76 mm

f. Minimum Life: 8,000 hours
g. Orientation: The bulb shall be installed with the opening between the filaments up.
h. Operation: The bulb shall operate properly between –40°C to 74°C.
i. Lens: The lens material shall be prismed glass. The lens shall be secured to the housing with four noncorrosive clips. The lens shall have a neoprene gasket making the display weather and dust tight.
j. Reflector: The reflector shall be specular aluminum with anodic coating.
k. Reflector Support: The reflector support shall be pivoted to the housing, and shall be designed so that it can be swung out or easily removed without the use of any tools.

9-29.16(2)B Signal Housing

The signal head housing, or case, shall consist of an assembly of separate sections, expansible type for vertical mounting, substantially secured together in a weathertight manner to form a unit of pleasing appearance. Each section shall house an individual optical unit.

Each section shall be complete with a one-piece, corrosion-resistant aluminum alloy die cast door and shall have a nominal 200-millimeter or 300-millimeter diameter opening for the lens. Each door shall be of the hinged type having two integrally cast hinge lugs and latch jaw. The door shall be attached to the housing by means of two noncorrosive, stainless steel hinge pins that are removable without the use of a special press or tool. A noncorrosive, stainless steel, threaded latch bolt and matching wing nut shall provide for opening and closing the door without the use of any special tools. Each door shall have a cellular neoprene gasket around the entire outer edge of the door, which, when the door is closed, shall make a positive weather and dust-tight seal. Each door shall have four tapped holes spaced about the circumference of the lens opening with four noncorrosive screws to accommodate the signal head visors. Each door shall have some device such as washers, clips, or keys, or be constructed so as to keep it from dismounting from the housing accidentally when it is open.

The body of each signal section shall consist of a one piece corrosion resistant, die cast aluminum alloy. Each section shall have serrated rings top and bottom so when used with proper brackets, each section may be adjustable in respect to an adjoining section, and the hangers may be locked securely to prevent moving. Cast integrally with the housing shall be two hinge lugs and one latch jaw. The top and bottom of the housing shall have an opening to accommodate standard 40-millimeter pipe brackets. The sections shall be so designed that when assembled, they interlock with one another forming one continuous weathertight unit. The sections shall be interchangeable and shall be dust and weathertight when assembled with the door and appropriate furnished hardware.

A terminal block of an approved type shall be mounted inside at the back of the housing. All sockets shall be so wired that a white wire will be connected to the shell of the socket and a wire, the color of the lens, to the bottom, or end terminal of the socket. These wires shall in turn be connected to the terminal block mounted in the housing, in the proper manner. The terminal block shall have sufficient studs to terminate all field wires and lamp wires independently to the block with separate screws. The terminals to which field wires are attached shall be permanently identified to facilitate field work.

Each lens shall be protected with a removable visor. The visor shall be tunnel type unless noted otherwise in the contract. Tunnel, cap, and cut away type visors shall be molded using ultraviolet and heat stabilized polycarbonate plastic material throughout. Visors shall be flat black in color inside and shall be flat black or dark green on the outside. Visors shall have attaching ears for installation to the housing door. The signal display shall have square doors. End caps shall be made from aluminum or plastic material and shall be installed with fittings to provide a watertight seal. A bead of silicone sealant shall be applied around the perimeter of all top end cap openings prior to installation of the end cap assembly. Plastic end caps shall utilize a threaded stud with seal and wing nut. Plastic end caps utilizing a metal screw that may damage the cap if overtightened will not be allowed. Plastic end caps shall have the same color as the signal housing.

9-29.16(2)C Louvered Visors

Where noted in the Contract, louvered tunnel visors shall be furnished and installed. Directional louvers shall be constructed to have a snug fit in the signal visor. The outside cylinder shall be constructed of polycarbonate plastic, and the louvers shall be constructed of anodized aluminum painted flat black. Dimensions and arrangement of louvers shall be as shown in the contract.

9-29.16(2)D Back Plates

Where noted in the Contract, back plates shall be furnished and attached to the signal heads. Back plates shall be constructed of black, flat finish, polycarbonate plastic.

9-29.16(2)E Painting Signal Heads

Traffic signal heads shall be finished with two coats of factory applied dark green (Federal Standard FS595A) baked enamel or shall be finished with a dark green oven baked powder coating comprised of resins and pigments. Aluminum end caps shall be painted to match the color of the signal housing.

9-29.16(3) Polycarbonate Traffic Signal Heads

Polycarbonate signal heads shall be provided only when specifically identified in the contract. With the exception of top and bottom bracket mountings, polycarbonate signal heads shall be installed with approved reinforcing plates located in signal sections adjacent to the mounting hardware.

9-29.16(3)A 200-Millimeter Polycarbonate Traffic Signal Heads

Polycarbonate employed in traffic signal fabrication shall tolerate an elongation prior to break in excess of 90 percent. The green color shall be molded throughout the head assembly. Polycarbonate lenses with a distortion temperature rating of 155°C shall be employed in the signal heads. The optical system shall be of the fixed focus type for 67 to 69 watt bulbs. The entire optical system shall be sealed by a single neoprene gasket. Alzak aluminum reflectors will be permitted in polycarbonate traffic signal head assemblies. The signal head shall be formed to be used with standard signal head mounting accessories. The optical system shall be consistent with ITE requirements.

9-29.16(3)B Three Hundred-Millimeter Polycarbonate Traffic Signal Heads

Three hundred-millimeter polycarbonate signal heads shall conform to all requirements of the 200-millimeter polycarbonate signal heads except the optical system shall be designed for a 1950 Lumen traffic signal lamp.

9-29.17 Signal Head Mounting Brackets and Fittings

Vehicle and pedestrian signal head mountings shall be as detailed in the Standard Plans. Material requirements for signal head mounts are as follows:

Aluminum

1. Hinge fittings for Type E mount.
2. Arms and slotted tube fittings for Type N mount.
3. Plumbizer, tapered adjustment washers and flange adapter fittings for Type M mount. The plumbizer shall be cast from tenzalloy AAA No. 713.
4. Tube clamp and female clamp assembly for Type N mount.

Bronze

1. Terminal compartments for Type A, B, C, F, H, and K mounts.
2. Collars for Type C, D, and F mounts.
3. Ell fittings for Type L and LE mounts.
4. Messenger hanger and wire entrance fittings for Type P, Q, R, and S mounts.
5. Balance adjuster for Type Q, R, and S mounts.

Galvanized Steel

1. Washers for Type A, B, C, D, F, H, and K mounts.
2. Fasteners for Type A, B, E, H, and K mounts.

Stainless Steel

1. All set screws and cotter Keys.
2. Bands for Type N mount.
3. Hinge pins for Type E mount.
4. Bolts, nuts and washers for Type M mount.
5. Bolt, nut and washers for Type L mount.
6. Bolts, nuts, washers, and screw buckle swivels.

Steel

1. Center pipes, nipples, elbow and tee fittings for Type A, B, C, F, H, and K mounts.
2. Multi-head mounting assemblies and spider assemblies for Type Q, R, and S mounts.
3. Nipples for Type L, LE, P, Q, R, and S mounts.

Fittings for Type M and N mounts shall be installed unpainted. All other hardware for other mounts shall be painted with two coats of factory applied traffic signal green baked enamel.

Pins for messenger hanger fittings shall be a minimum of 12.5 millimeters in diameter.

Terminal compartments for Type A, B, C, F, H, and K mounts shall contain a 12 section terminal block.

9-29.18 Vehicle Detector

Induction loop detectors and magnetometer detectors shall comply with current NEMA specifications when installed with NEMA control assemblies and shall comply with the California Department of Transportation document entitled "Traffic Signal Control Equipment Specifications," specified in Section 9-29.13(7) when installed with Type 170 control assemblies.

9-29.18(1) Induction Loop Detectors

When required in the contract, amplifier units shall be provided with supplemental timing features identified as follows:

1. Delay Timing. When delay timing is required, the unit shall delay detector output for up to 15 seconds minimum, settable in one second maximum intervals.
2. Delay Timing With Gate. When delay timing with gate is required, the unit shall provide delay timing features as noted above with the additional capability of inhibiting delay timing when an external signal is applied.
3. Extension Timing. When extension timing is required, the unit shall extend the detector output for up to 7 seconds minimum, settable in 0.5 second minimum intervals.
4. Delay and Extension Timing With Gate. When delay and extension timing with gate is required, the unit shall provide both delay and extension timing features as noted above with the additional capability of inhibiting delay while enabling extension upon application of an external signal. Without external signal, the unit shall inhibit extension and enable delay.

9-29.18(2) Magnetometer Detectors

Magnetometer detector units and sensors shall conform to the following specifications:

1. Operation. The magnetometer detector unit shall respond to changes in the earth's local magnetic field caused by the passage of a vehicle containing iron or steel over the sensor unit.
2. Environmental Requirements. Satisfactory operation shall be attained over the ambient temperature range from -34°C to 70°C. Operation shall be unaffected by temperature change, water, ice, pavement deterioration, or electromagnetic noise.
3. Modes of Operation. Each detector channel shall be capable of functioning in any of four front-panel selectable modes:
   a. Presence. Time of detection shall be unlimited.
   b. Extended Presence. The detection output shall extend for a timer set value of up to 5 seconds after the detection zone has cleared.
   c. Pulse. A single 30 to 50 millisecond pulse will be generated per detection actuation.
   d. Inhibited Pulse. The detection output will be inhibited for a time set value of up to 5 seconds after the detection zone has cleared.
4. Response Time. Pick up and drop out times shall be consistently within 10 milliseconds.
5. Approach Speed. The unit shall be capable of detecting vehicles traveling from 0 to 135 kilometers per hour.
6. Sensor Probes. Each channel of the detector unit shall be capable of operating up to three sensing probes. Probes shall be cylindrical and shall be suitable for installation in a 25-millimeter diameter bored hole.

9-29.19 Pedestrian Push Buttons

Where noted in the contract, pedestrian push buttons of substantially tamper-proof construction shall be furnished and installed. They shall consist of a 57-millimeter diameter chrome plated mushroom plunger and a single momentary contact switch in a cast metal housing assembled with the push button sign shown in the plans. The switch shall have snap action contacts, actuated by a three bladed beryllium copper spring, and shall be rated 10 amperes, 125 volts.

The pedestrian push-button assembly shall be constructed and mounted as detailed in the contract. The assembly shall be constructed so that it will be impossible to receive an electrical shock under any weather conditions.

9-29.20 Pedestrian Signal

Pedestrian signals shall be either incandescent or neon-grid type, as specified in the contract. Pedestrian signals shall conform to ITE Standards (Standard for Adjustable Face Pedestrian Signal Heads, 1975).

Incandescent pedestrian signal heads shall employ a 116 watt clear traffic signal lamp rated for 120 volt operation. It shall be rated 1280 initial lumen, 8000 hour average life, 62-millimeter light center length, A-21 bulb.

All pedestrian signals supplied to any one project shall be from the same manufacturer and type but need not be from the same manufacturer as the vehicle heads.

Word messages, when specified, shall provide letters a minimum of 114 millimeters high. Symbol messages, when specified, shall be a minimum of 300 millimeters high and 178 millimeters in width.

Housings shall be die-cast aluminum and shall be painted with two coats of factory applied traffic signal green enamel.

Neon grid pedestrian heads shall be solid state type and shall be supplied with Z crate visors. Z crate visors shall have 21 members at 45 degrees and 20 horizontal members. The unit shall be 38 millimeters deep. Members shall be constructed of 0.76 millimeters thick black polycarbonate plastic.

9-29.20(1) Vacant

9-29.20(2) Neon Grid Type

All neon grid heads shall be equipped with Z crate visors.

Neon tubing shall be enclosed and shock-mounted inside a rugged plastic module.

A combination switch/fuse holder shall be provided for each transformer. Each unit shall provide a grounding terminal.

Transformers shall provide recessed secondary contacts and integral Pyrex glass electrode housing.

9-29.21 Flashing Beacon

Flashing beacons shall be installed as detailed in the Plans, as specified in the Special Provisions, and as described below.

Controllers for flashing beacons shall be as specified in Section 9-29.15.

Beacons shall consist of single section, 200-millimeter or 300-millimeter traffic signal heads, three- or four-way adjustable, meeting all of the applicable requirements of Section 9-29.16. Mounting brackets, mountings, and installation shall meet all applicable requirements of Section 9-29.17.

Lenses shall be either red or amber, as noted in the Plans or as determined by the Engineer.

9-29.22 Vacant

9-29.23 Vacant

9-29.24 Service Cabinets

In addition to the requirements for service cabinets indicated in the contract, the following requirements shall apply:

All electrical conductors, buss bars, and conductor terminals shall be copper. Conductor insulation shall be either THW, XHHW, USE, or SIS.

If field wiring larger than that which the contactors or breakers will accommodate is required by the contract, a terminal board shall be supplied for use as a splicing block.

The minimum size of all other load carrying conductors used within the service cabinets shall be based on the National Electrical Code ampacity tables for not more than three conductors in a raceway or cable.

Type C, D, and E Cabinets shall have ventilation louvers on the lower sides complete with screens and filters. They shall also have rain-tight cabinet vents with screens at the top. Cabinet vents shall be gasketed.

Type D and E cabinets shall have provision for two future circuit breakers. The dead front cover shall have cutouts with covers for this provision. The receptacle breaker shall be ground fault interrupter equipped.

The minimum size of control circuit conductors used in service cabinets shall be No. 14 AWG.

All electrical contactors shall have the loadside terminals toward the front (door side) of the service cabinet.

The lighting contactors used shall be specifically rated for tungsten fluorescent and mercury arc lamp loads.

Type A or B service enclosures shall be fabricated from steel or aluminum. If aluminum, they shall be fabricated from 2 millimeters 6061-T6 aluminum. If steel, they shall be fabricated from 16 gage galvanized (electro or hot-dipped) steel. Electro galvanized enclosures shall have a factory applied gray enamel finish.

Types C, D, and E service cabinets shall be fabricated from 12 gage sheet steel. Type C steel cabinets shall be hot-dip galvanized finish per ASTM A 123.

Where aluminum cabinets are allowed, riveted type construction developing rain-tight fabrication will be permitted in lieu of welding.

All dead front panels installed in service cabinets shall incorporate a piano hinge placed in a vertical plane. The side opposite the hinge shall be secured with quarter turn screws. No electrical devices shall be connected to the dead panel. However, every switch serviced through the dead front panel shall be appropriately identified with its respective circuit designation by means of a screwed or riveted engraved name plate. Such circuit identification shall be submitted for approval together with the appropriate fabrication drawings. Dead front panels shall be intended to provide security only to the switching segment of the service enclosure and need not cover the electrical contactor portion.

A typed index of all circuits shall be mounted on the cabinet door. Each index shall show an entire panel section without folding. Index holders shall have metal returns on the sides and bottom. A schematic of the main panel, any subpanels, circuits, and control circuits shall be provided. The schematic shall be plastic coated and secured in a metal holder.

9-29.24(1) Painting

Painting shall be done in conformance with the provisions of Section 8-20.3(12).

Type D and E service cabinets shall be cleaned in accordance with Section 6-07, then painted according to the following schedule:

First Coat:	(Outside and inside) A-9-73 Galvanizing Repair Paint
Second Coat:	(Outside and inside) A-5-61 Vinyl Pretreatment
Third Coat:	(Outside only) Shop finish coat — Aluminum paint D-1-57
Fourth Coat:	(Outside only) Field finish coat — Aluminum paint D-1-57

The interior shall be given one finish coat of exterior white metal enamel. Each coat shall be dry before application of the next coat and hard dry upon shipment to the job site.

9-29.24(2) Electrical Circuit Breakers and Contactors

Lighting contactors shall be rated 240 volts maximum line to line, or 277 volt maximum line to neutral voltage for tungsten and ballasted lamp loads on 120/240/277 volt circuits, whichever is applicable, or they shall be rated 480 volt maximum line to line voltage for higher than 277 volt circuited tungsten or ballasted lamp loads.

As an alternate to the lighting contactor, the Contractor may furnish a double contact mercury relay. The relay ampere rating shall equal or exceed the rating noted in the contract. The relay shall be normally open and shall be rated for up to 480 VAC. resistive. The unit shall have a molded coil enclosure rated for 120 VAC. The contacts shall be evacuated,

backfilled with an inert gas and shall be hermetically sealed. The electrode shall be one piece with Teflon wear rings on the internal plunger assembly. All contact terminals and coil connection clamps shall be U.L. approved.

Circuit breakers shall be 240 or 277 volt maximum rated for 120/240/277 volt circuits, whichever is applicable, and shall have an interrupting capacity (R.M.S. — symmetrical) of not less than 10,000 amperes. They shall have not less than 480 volt rated for circuits above 277 volts and shall have an interrupting capacity (R.M.S. — symmetrical) of not less than 14,000 amperes. Circuit breakers shall be bolt-on type.

9-29.25 Amplifier, Transformer, and Terminal Cabinets

Amplifier, terminal, and transformer cabinets shall conform to NEMA 3R requirements and the following:

1. All cabinets shall be constructed of welded 14 gage (minimum) sheet steel or 2-millimeter aluminum (5052 or 6061 alloy).
2. Nominal cabinet dimensions shall be:

		Depth	Height	Width
a.	Terminal	200 mm	400 mm	300 mm
b.	Amplifier	350 mm	600 mm	450 mm
c.	Transformer	300 mm	450 mm	450 mm

3. Cabinet doors shall be gasketed with a one-piece closed cell neoprene gasket and shall have a stainless steel piano hinge. The door shall also be provided with a spring loaded construction core lock capable of accepting a Best CX series core. The locking mechanism shall provide a tapered bolt.
4. All seams shall be continuously welded.
5. All cabinets shall provide a drip shield.
6. Transformer cabinets shall provide a 5800-square millimeters minimum louvered vent.
7. One spare 12-position terminal block shall be installed in each terminal cabinet and amplifier cabinet.
8. Painting of steel cabinets shall comply with Section 8-20.3(12). Aluminum cabinets need not be painted.
9. Mounting shall be as noted in the contract.

9-30 WATER DISTRIBUTION MATERIALS

This specification addresses pipe and appurtenances 400 millimeters in diameter and smaller. Water distribution material incorporated in the work shall be new.

The Contractor shall provide to the Engineer the names of the manufacturer(s) of the water distribution materials proposed for inclusion in the work, which materials shall conform in every respect to these specifications. If so required by the Special Provisions, the Contractor shall provide to the Engineer in addition to the names of the manufacturer(s) of the water distribution materials, a Manufacturer's Certificate of Compliance meeting the provisions of Section 1-06.3, for the materials proposed for inclusion in the work. As used in this specification, the term "lot of material delivered to the work" shall mean a shipment of the water distribution materials as it is delivered to the work.

The Engineer shall have free access to all testing and records pertaining to material to be delivered to the job site. The Engineer may elect to be present at any or all material testing operations.

9-30.1 Pipe

All pipe shall be clearly marked with the manufacturer's name, type, class, and thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.

9-30.1(1) Ductile Iron Pipe

1. Ductile iron pipe shall be centrifugally cast and meet the requirements of AWWA C151. Ductile iron pipe shall have a cement-mortar lining meeting the requirements of AWWA C104. Ductile iron pipe to be joined using bolted flanged joints shall be Standard Thickness Class 53. All other ductile iron pipe shall be Standard Thickness Class 50 or the thickness class as shown in the Plans.
2. Nonrestrained joints shall be rubber gasket, push-on type, or mechanical type meeting the requirements of AWWA C111.
3. Restrained joints shall be as specified in Section 9-30.2(6).

9-30.1(2) Vacant

9-30.1(3) Vacant

9-30.1(4) Steel Pipe

9-30.1(4)A Steel Pipe (150 Millimeters and Over)

Steel pipe 150 millimeters in diameter and larger shall conform to AWWA C200. The type of protective coating and lining and other supplementary information required by AWWA C200 shall be included in the Special Provisions.

9-30.1(4)B Steel Pipe (100 Millimeters and Under)

Steel pipe 100 millimeters in diameter and smaller shall be hot-dip galvanized inside and out and meet the requirements of ASTM A 53.

9-30.1(5) Polyvinyl Chloride (PVC)

9-30.1(5)A Polyvinyl Chloride (PVC) Pipe (100 Millimeters and Over)

PVC pipe for distribution pipelines shall meet the requirements of AWWA C900. PVC pipe shall have the same outside dimensions as ductile iron pipe. PVC pipe for distribution pipelines shall be a minimum of SDR 18. Pipe shall be listed by Underwriters' Laboratories, Inc.

PVC pipe shall be considered flexible conduit. Joints shall meet the requirements of ASTM D 3139 using a restrained rubber gasket conforming to ASTM F 477. Solvent welded pipe joints are not permitted.

9-30.1(5)B Polyvinyl Chloride (PVC) Pipe (Under 100 Millimeters)

Polyvinyl chloride (PVC) under 100 millimeters shall meet the requirements of ASTM D 2241. Pipe material shall be PVC 1120, PVC 1220, or PVC 2120, and shall have minimum wall thickness equal or greater than a standard dimension ratio (SDR) of 21. Pipe shall bear the National Sanitation Foundation Seal for use to transport potable water. Pipe shall be considered flexible conduit. Joints shall meet the requirements of ASTM D 3139 using a restrained rubber gasket meeting the requirements of ASTM F 477.

9-30.2 Fittings

Bolts, nuts, and washers used for securing fittings shall be of similar materials. Steel bolts shall meet the requirements of ASTM A 307 or ASTM F 568 for carbon steel or ASTM F 593 or ASTM F 738M for stainless steel. Nuts shall meet the requirements of ASTM A 563 or ASTM A 563 for carbon steel or ASTM F 594 or ASTM F 836 for stainless steel. Iron bolts and nuts shall meet the requirements of ASTM A 536, grade 65-45-12.

9-30.2(1) Ductile Iron Pipe

Fittings for ductile iron pipe shall meet the requirements of AWWA C110 or AWWA C153. Joints shall meet the requirements of AWWA C111. Fittings shall be cement mortar lined, meeting the requirements of AWWA C104. Gaskets for flat faced or raised faced flanges shall be 3 millimeters thick neoprene having a durometer of 60 plus or minus 5 or $^{1}/_{16}$-cloth inserted. The type, material, and identification mark for bolts and nuts shall be provided.

9-30.2(2) Vacant

9-30.2(3) Vacant

9-30.2(4) Steel Pipe

9-30.2(4)A Steel Pipe (150 Millimeters and Over)

Fittings for steel pipe 150 millimeters and over shall receive a coal tar protective treatment meeting the requirements of AWWA C203. Field couplings shall be compression type. When flanges are required, they shall meet the requirements of AWWA C207.

9-30.2(4)B Steel Pipe (100 Millimeters and Under)

Fittings for steel pipe 100 millimeters and under shall be malleable iron threaded type with a pressure rating of 1000 kilopascals. Dimensions shall meet the requirements of ANSI B16.3. Threading shall meet the requirements of ANSI B2.1. Material shall meet requirements of ASTM A 47M, Grade 32510. Fittings shall be banded and hot-dip galvanized inside and out.

9-30.2(5) Polyvinyl Chloride (PVC) Pipe

9-30.2(5)A Polyvinyl Chloride (PVC) Pipe (100 Millimeters and Over)

Fittings for PVC pipe shall be the same as specified for ductile iron pipe.

9-30.2(5)B Polyvinyl Chloride (PVC) Pipe (Under 100 Millimeters)

Fittings for PVC pipe under 100 millimeters shall meet the requirements of ASTM D 2466.

9-30.2(6) Restrained Joints

The restraining of ductile iron pipe, fittings, and valves shall be accomplished by the use of either a bolted or boltless system. Any device utilizing round point set screws shall not be permitted.

All couplings installed underground to connect ductile iron or PVC pipe shall be manufactured of ductile iron.

9-30.2(7) Bolted, Sleeve-Type Couplings for Plain End Pipe

Bolted, sleeve-type couplings, reducing or transition couplings, and flanged coupling adapters used to join plain-end pipe shall meet the requirements of AWWA C219. Buried couplings to connect ductile iron, gray cast iron, or PVC pipe shall be ductile iron. Buried couplings for connecting steel pipe to steel pipe shall be steel.

9-30.2(8) Restrained Flexible Couplings

Restrained flexible couplings shall be lock couplings for drilled end pipe in accordance with the Plans or Special Provisions. Coupling shall be epoxy coated.

9-30.3 Valves

Valves shall be provided with hand wheels or operating nuts as designated. Where operating nuts are called for, a standard 50-millimeter operating nut shall be furnished. Valves shall be nonrising stem type, open counterclockwise, and be equipped with an O-ring stuffing box.

9-30.3(1) Gate Valves (75 Millimeters to 300 Millimeters)

Gate valves shall meet the requirements of AWWA C500 or AWWA C509.

9-30.3(2) Gate Valves (350 Millimeters and 400 Millimeters)

Gate valves 350 millimeters in size shall meet the requirements of AWWA C500. Gate valves 400 millimeters in size shall be arranged for operation in the horizontal position with gear case.

Valves shall be equipped with bypasses and gate valves of the sizes adopted in the AWWA Standards. Bypass gate valves shall be equipped with standard 50-millimeter operating nuts.

Prior to shipping, three certified copies of performance tests, as specified in Section 5 of AWWA C500, shall be submitted to the Engineer for review.

9-30.3(3) Butterfly Valves

Butterfly valves shall be rubber seated and shall meet the requirements of AWWA C504, Class 150B. Butterfly valves shall be suitable for direct burial.

Valve operators shall be of the traveling nut or worm gear type, sealed, gasketed, and permanently lubricated for underground service. Valve operators shall be constructed to the standard of the valve manufacturer to withstand all anticipated operating torques and designed to resist submergence in ground water.

The Contractor shall provide an affidavit of compliance stating that the valve furnished fully complies with AWWA C504.

9-30.3(4) Valve Boxes

Valve boxes shall be installed on all buried valves. The box shall be of cast iron, two-piece slip type standard design with a base corresponding to the size of the valve. The box shall be coal-tar painted by the manufacturer using its standard. The cover shall have the word "WATER" cast in it.

9-30.3(5) Valve Marker Posts

Posts shall have a 100-millimeter minimum square section and a minimum length of 1 meter, with beveled edges and shall contain at least one No. 3 bar reinforcing steel.

The exposed portion of the marker posts shall be coated with two coats of concrete paint in a color selected by the Contracting Agency.

The size of the valve and the distance in meters to the valve shall be stenciled on the face of the post, using black paint and a stencil which will produce letters 50 millimeters high.

9-30.3(6) Valve Stem Extensions

Valve stem extensions shall have a 50-millimeter square operating nut and self-centering rockplate support. Valves with an operating nut more than 1.2 meters below grade shall have a valve stem extension to raise the operating nut to within 900 millimeters of the ground surface.

9-30.3(7) Combination Air Release/Air Vacuum Valves

Combination air release/air vacuum valves shall be designed to operate with potable water under pressure to permit discharging a surge of air from an empty line when filling and relieve the vacuum when draining the system. The valves shall also release an accumulation of air when the system is under pressure. This shall be accomplished in a single valve body designed to withstand 2000 kilopascals.

The body and cover shall be cast iron conforming to ASTM A 48, Class 30. Floats shall be stainless steel conforming to ASTM A 240 and designed to withstand 7 megapascals. Seats shall be Buna N rubber. Internal parts shall be stainless steel or bronze.

9-30.3(8) Tapping Sleeve and Valve Assembly

Tapping valves shall be furnished with flanged inlet end connections. The outlet ends shall conform in dimensions to the AWWA Standards for hub or mechanical joint connections, except that the outside of the hub shall have a large flange for attaching a drilling machine. The seat opening of the valve must permit a diameter cut no less than 13 millimeters smaller than the valve size. Valves specifically designed for tapping meeting the requirements of AWWA C500, and valves meeting the requirements of AWWA C509, will be permitted. Tapping valves shall be of the same type as other valves on the project. Tapping sleeves shall be cast iron, ductile iron, stainless steel, epoxy coated steel, or other approved material.

9-30.4 Vacant

9-30.5 Hydrants

Fire hydrants shall conform to AWWA C502 and shall be of standard manufacture and of a pattern approved by the Contracting Agency.

9-30.5(1) End Connections

The end connections shall be mechanical joint or flanged, meeting the requirements of AWWA C110 and C111.

9-30.5(2) Hydrant Dimensions

Hydrant connection pipes shall be 150 millimeters inside diameter with 150-millimeter auxiliary gate valves. Barrels shall have a 175-millimeter minimum inside diameter. Hydrant length, measured from the bottom of the hydrant to the sidewalk ring, shall provide proper cover at each installed location. Valve openings shall be 133 millimeters minimum diameter. Hydrants shall have two 64-millimeter hose nozzles and one pumper nozzle to match Contracting Agency's connection requirements.

Nozzles shall be fitted with cast iron threaded caps with operating nuts of the same design and proportions as the hydrant stem nuts. Caps shall be threaded to fit the corresponding nozzles and shall be fitted with suitable neoprene gaskets of positive water tightness under test pressures. The direction of opening shall be counterclockwise and shall be clearly marked on the operating nut or hydrant top. Hydrants shall be with O-ring stem seals. The hydrant shall be painted with two coats of paint to match the owner's existing hydrants.

9-30.5(3) Hydrant Extensions

Hydrant extensions shall have a 150-millimeter minimum inside diameter and shall be gray cast iron or ductile iron and shall conform to the AWWA Standards for such castings. The drillings of the connecting flanges on the extensions shall match the drillings of the flanges on the hydrant.

Hydrant extensions shall also include the necessary hydrant operating stem extensions.

9-30.5(4) Hydrant Restraints

Shackle rods shall be 19-millimeter diameter with threaded ends, and shall be ASTM A 36M Steel. Shackle rods shall be coated with two coats of asphalt varnish. If a restrained joint system is used, it shall meet the requirements of Section 9-30.2(6).

9-30.5(5) Traffic Flange

Hydrants shall be provided with a traffic flange and shall be equipped with breaking devices at the traffic flange which will allow the hydrant barrel to separate at this point with a minimum breakage of hydrant parts in case of damage. There shall also be provided at this point, a safety stem coupling on the operating stem that will shear at the time of impact.

9-30.5(6) Guard Posts

Guard posts for hydrants shall be provided where shown in the Plans. Guard posts shall be reinforced concrete having a compressive strength of 24 megapascals and shall be 1.8 meters in length by 225 millimeters in diameter. Reinforcing shall consist of a minimum of five No. 3 deformed steel bars.

9-30.6 Water Service Connections (50 Millimeters and Smaller)

9-30.6(1) Saddles

Saddles shall be ductile iron, bronze, or stainless steel.

Saddles used for 19-millimeter and 25-millimeter services shall be single strap and may be either AWWA tapered thread or female iron pipe thread outlet. Saddles used for 38-millimeter and 50-millimeter services shall be double strap and shall be female iron pipe thread outlet. Saddles used on PVC pipe shall be formed for PVC pipe and have flat, stainless steel straps.

9-30.6(2) Corporation Stops

Corporation stops shall be made of bronze alloy.

Corporation stops for direct tapping shall have AWWA tapered thread inlet and an outlet connections compatible with either copper or polyethylene tubing.

Corporation stops used with 19-millimeter and 25-millimeter outlet saddles shall have either AWWA tapered thread or male iron pipe thread inlets and outlet connections compatible with either copper or polyethylene tubing. Thread patterns for the saddle outlet and corporation stop inlet shall be the same.

Corporation stops used with 38-millimeter and 50-millimeter outlet saddles shall have male iron pipe thread inlets and outlet connections compatible to connecting service pipes or have male iron pipe thread outlets.

9-30.6(3) Service Pipes

9-30.6(3)A Copper Tubing

Copper tubing shall be annealed, seamless, and conform to the requirements of ASTM B 88M, Type K.

9-30.6(3)B Polyethylene Tubing

Polyethylene tubing shall meet the requirements of AWWA C901. Tubing shall be high molecular mass with a 1400 kilopascals rating. Tubing used for 19-millimeter and 25-millimeter shall be either SIDR 7 (iron pipe size) or SDR 9 (copper tube size). Tubing used for 38-millimeter and 50-millimeter shall be SDR 9 (copper tube size).

9-30.6(4) Service Fittings

Fittings used for service connections shall be made of bronze alloy.

Fittings used for copper tubing shall be either compressions or flare type.

Fittings used for polyethylene tubing shall be either compression or stab type. Stab type fittings shall utilize an internal grip ring and O-ring seal. Stainless steel liners shall be used when utilizing compression fittings on polyethylene tubing.

9-30.6(5) Meter Setters

Meter setters shall be manufactured and tested in accordance with all applicable parts of AWWA C800.

Meter setters shall have an angle meter stop with drilled padlock wing, an angle check valve, measure 300 millimeters in height, and shall have an inlet and outlet threads compatible with fittings connecting to service pipes.

Meter setters for 16-millimeter by 19-millimeter, 19-millimeter, and 25-millimeter services shall have meter saddle nuts for installation and removal of the meter.

Meter setters for 38-millimeter and 50-millimeter services shall be equipped with a locking bypass.

9-30.6(6) Bronze Nipples and Fittings

Bronze threaded nipples and fittings shall meet the requirements of ANSI B-16.15, ASA 57 kilogram class.

9-30.6(7) Meter Boxes

Meter boxes and covers located in the nontraffic areas shall be constructed of either reinforced concrete or high density polyethylene. High density polyethylene meter boxes and covers shall have a tensile strength conforming to ASTM D 638M. Meter box covers shall include a reading lid.

Meter boxes located in traffic areas shall be constructed of either reinforced concrete, cast iron, or ductile iron. Traffic covers shall be constructed of either aluminum, steel, cast iron, or ductile iron. Meter boxes and covers shall be designed for H-20 loading.

9-31 ELASTOMERIC BEARING PADS

9-31.1 Requirements

Elastomeric bearing pads shall conform to the requirements of AASHTO M 251. The elastomer shall not contain any form of wax.

All bearing pads shall be individually cast with fully molded edges. Corners and edges of molded pads may be rounded at the option of the Contractor. Radius at corners shall not exceed 10 millimeters, and radius of edges shall not exceed 3 millimeters.

Shims contained in laminated bearing pads shall be mill rolled steel sheets not less than 20 gage in thickness with a minimum cover of elastomer on all edges of:

3 millimeters for pads up to 75 millimeters thick, and
6 millimeters for pads over 75 millimeters thick.

The shims shall be spaced to divide the pad thickness into equal laminations. The bond between the elastomer and metal shims shall be such that, when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and the metal shim.

The grade or durometer hardness of the bearing pads shall be as noted in the contract.

Elastomeric bearing pads shall be manufactured with the following tolerances:

Overall vertical dimensions:	
Design thickness 32 millimeters or less	–0, +3 millimeters
Design thickness over 32 millimeters	–0, +6 millimeters
Overall horizontal dimensions:	
914 millimeters and less	–0, +6 millimeters
Over 914 millimeters	–0, +12 millimeters

9-32 MAILBOX SUPPORT

9-32.1 Tube

The tube shall be 50 millimeters outside diameter, 14 gage, mechanical tubing, and shall conform to ASTM A 513. Galvanizing shall conform to G 90 coating as defined in ASTM A 525M, or an approved equal.

Any damage to galvanized surfaces shall be treated with two coats of formula A-9-73, Galvanizing Repair Paint, High Zinc Dust Content, as specified in Section 9-08.2.

9-32.2 Mounting Bracket

The mounting bracket shall be 16 gage sheet steel, conforming to ASTM A 526M.

9-32.3 Post Mounting Socket and Wedge

The post mounting socket shall be made from 12 gage hot rolled carbon sheet steel, shall conform to ASTM A 569M and shall be galvanized after fabrication in accordance with AASHTO M 111.

The wedge shall be made from 12 gage steel tubing and shall conform to ASTM A 513.

9-32.4 Wood Posts

Wood posts shall be treated Western red cedar, Douglas fir, or Hem-fir meeting the grades specified in Section 9-09.2. Posts shall be given a preservative treatment meeting the requirements of Section 9-16.2(3).

9-32.5 Hardware

Unless otherwise specified, bolts and nuts shall be commercial bolt stock, galvanized in accordance with ASTM A 153. Washers, unless otherwise specified, shall be malleable iron, or cut from medium steel or wrought iron plate. Washers and other hardware shall be galvanized in accordance with AASHTO M 111.

9-33 CONSTRUCTION GEOTEXTILE

9-33.1 Geotextile and Thread for Sewing

The material shall be a geotextile consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by mass of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties as indicated in Tables 1 through 6 for each use specified in the Plans. Specifically, the geotextile uses included in this section and their associated tables of properties are as follows:

Geotextile Application	Applicable Property Tables
Underground Drainage, Low Survivability, Classes A, B, and C	Tables 1 and 2
Underground Drainage, Moderate Survivability, Classes A, B, and C	Tables 1 and 2
Separation	Table 3
Soil Stabilization	Table 3
Permanent Erosion Control, Moderate Survivability, Classes A, B, and C	Tables 4 and 5
Permanent Erosion Control, High Survivability, Classes A, B, and C	Tables 4 and 5
Ditch Lining	Table 4
Temporary Silt Fence	Table 6

Thread used for sewing shall consist of high strength polypropylene, polyester, or polyamide. Nylon threads will not be allowed. The thread used to sew permanent erosion control geotextiles must also be resistant to ultraviolet radiation. The thread shall be of contrasting color to that of the geotextile itself.

9-33.2 Geotextile Properties

Table 1

Geotextile for underground drainage strength properties for survivability.

		Geotextile Property Requirements[1]	
Geotextile Property	**Test Method[2]**	**Low Survivability Woven/Nonwoven**	**Moderate Survivability Woven/Nonwoven**
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	800 N/500 N min.	1100 N/700 N min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	<50%/≥50%	<50%/≥50%
Seam Breaking Strength	ASTM D4632[3]	700 N/450 N min.	990 N/630 N min.
Puncture Resistance	ASTM D4833	300 N/180 N min.	350 N/220 N min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	300 N/180 N min.	350 N/220 N min.
Ultraviolet (UV) Radiation stability	ASTM D4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

Table 2

Geotextile for underground drainage filtration properties.

		Geotextile Property Requirements[1]		
Geotextile Property	**Test Method[2]**	**Class A**	**Class B**	**Class C**
AOS	ASTM D4751	.43 mm max. (0.425 mm sieve)	.25 mm max. (0.25 mm sieve)	.18 mm max. (0.18 mm sieve)
Water Permittivity	ASTM D4491	.5 sec^{-1} min.	.4 sec^{-1} min.	.3 sec^{-1} min.

Table 3

Geotextile for separation or soil stabilization.

		Geotextile Property Requirements[1]	
Geotextile Property	**Test Method[2]**	**Separation Woven/Nonwoven**	**Soil Stabilization Woven/Nonwoven**
AOS	ASTM D4751	.60 mm max. (0.60 mm sieve)	.43 mm max. (0.45 mm sieve)
Water Permittivity	ASTM D4491	.02 sec^{-1} min.	.10 sec^{-1} min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	1100 N/700 N min.	1400 N/900 N min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	<50%/≥50%	<50%/≥50%
Seam Breaking Strength	ASTM D4632[3]	990 N/630 N min.	1200 N/800 N min.
Puncture Resistance	ASTM D4833	350 N/220 N min.	500 N/350 N min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	350 N/220 N min.	500 N/350 N min.
Ultraviolet (UV) Radiation stability	ASTM D4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

Table 4

Geotextile for permanent erosion control and ditch lining.

		Geotextile Property Requirements[1]		
		Permanent Erosion Control		Ditch Lining
Geotextile Property	**Test Method[2]**	**Moderate Servivability Woven/Nonwoven**	**High Survivability Woven/Nonwoven**	**Woven/Nonwoven**
AOS	ASTM D4751	See Table 5	See Table 5	.60 mm max (0.60 mm sieve)
Water Permittivity	ASTM D4491	See Table 5	See Table 5	.02 sec^{-1} min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	1100 N/700 N min.	1400 N/900 N min.	1100 N/700 N min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	15%-50%/>50%	15%-50%/>50%	<50%/≥50%
Seam Breaking Strength	ASTM D4632[3]	990 N/630 N min.	1200 N/800 N min.	990 N/630 N min.
Burst Strength	ASTM D3786	2700 kPa/1300 kPa min.	3500 kPa/2200 kPa min.	
Puncture Resistance	ASTM D4833	350 N/220 N min.	500 N/350 N min.	350 N/220 N min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	350 N/220 N min.	500 N/350 N min.	350 N/220 N min.
Ultraviolet (UV) Radiation stability	ASTM D4355	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer

Table 5

Filtration properties for geotextile for permanent erosion control.

		Geotextile Property Requirements[1]		
Geotextile Property	**Test Method[2]**	**Class A**	**Class B**	**Class C**
AOS	ASTM D4751	.43 mm max. (0.425 mm sieve)	.25 mm max. (0.25 mm sieve)	.22 mm max. (0.212 mm sieve)
Water Permittivity	ASTM D4491	.7 sec^{-1} min.	.4 sec^{-1} min.	.2 sec^{-1} min.

Table 6

Geotextile for temporary silt fence.

		Geotextile Property Requirements[1]	
Geotextile Property	**Test Method[2]**	**Unsupported Between Posts**	**Supported Between Posts with Wire or Polymeric Mesh**
AOS	ASTM D4751	.60 mm max. for slit film wovens (0.60 mm sieve) .30 mm max for all other geotextile types (0.30 mm sieve) .15 mm min. (0.15 mm sieve)	.60 mm max. for slit film wovens (0.60 mm sieve) .30 mm max. for all other geotextile types (0.30 mm sieve) .15 mm min. (0.15 mm sieve)
Water Permittivity	ASTM D4491	.02 sec^{-1} min.	.02 sec^{-1} min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	800 N min. in machine direction, 450 N min. in x-machine direction	450 N min
Grab Failure Strain, min. in machine direction only	ASTM D4632	30% max. at 800 N or more	
Ultraviolet (UV) Radiation Stability	ASTM D4355	70% Strength Retained min., after 500 hrs. in weatherometer	70% Strength Retained min., after 500 hrs. in weatherometer

[1]All geotextile properties in Tables 1 through 6 are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the table).

[2]The test procedures used are essentially in conformance with the most recently approved ASTM geotextile test procedures, except for geotextile sampling and specimen conditioning, which are in accordance with WSDOT Test Methods 914 and 915, respectively. Copies of these test methods are available at the Olympia Service Center Materials Laboratory in Tumwater.

[3]With seam located in the center of 200-millimeter long specimen oriented parallel to grip faces.

9-33.3 Aggregate Cushion of Permanent Erosion Control Geotextile

Aggregate cushion for permanent erosion control geotextile, Class A shall meet the requirements of Section 9-03.9(2). Aggregate cushion for permanent erosion control geotextile, Class B or C shall meet the requirements of Section 9-03.9(3) and 9-03.9(2).

9-33.4 Geotextile Approval and Acceptance

9-33.4(1) Source Approval

The contractor shall submit to the Engineer the following information regarding each geotextile proposed for use:

Manufacturer's name and current address,
Full product name,
Geotextile structure, including fiber/yarn type, and
Proposed geotextile use(s).

If the geotextile source has not been previously evaluated, a sample of each proposed geotextile shall be submitted to the Olympia Service Center Materials Laboratory in Tumwater for evaluation. After the sample and required information for each geotextile type have arrived at the Olympia Service Center Materials Laboratory in Tumwater, a maximum of 14 calendar days will be required for this testing. Source approval will be based on conformance to the applicable values from Tables 1 through 6 in Section 9-33.2. Source approval shall not be the basis of acceptance of specific lots of material unless the lot sampled can be clearly identified and the number of samples tested and approved meet the requirements of WSDOT Test Method 914.

9-33.4(2) Geotextile Samples for Source Approval

Each sample shall have minimum dimensions of 1.5 meters by the full roll width of the geotextile. A minimum of 6 squares meters of geotextile shall be submitted to the Engineer for testing. The geotextile machine direction shall be marked clearly on each sample submitted for testing. The machine direction is defined as the direction perpendicular to the axis of the geotextile roll. Source approval for temporary silt fences will be by manufacturer's certificate of compliance as described under "Acceptance Samples."

The geotextile samples shall be cut from the geotextile roll with scissors, sharp knife, or other suitable method which produces a smooth geotextile edge and does not cause geotextile ripping or tearing. The samples shall not be taken from the outer wrap of the geotextile roll nor the inner wrap of the core.

9-33.4(3) Acceptance Samples

Samples will be randomly taken by the Engineer at the job site to confirm that the geotextile meets the property values specified.

Approval will be based on testing of samples from each lot. A "lot" shall be defined for the purposes of this specification as all geotextile rolls within the consignment (i.e., all rolls sent the project site) which were produced by the same manufacturer during a continuous period of production at the same manufacturing plant and have the same product name. After the samples have arrived at the Olympia Service Center Materials Laboratory in Tumwater, a maximum of 14 calendar days will be required for this testing. If the results of the testing show that a geotextile lot, as defined, does not meet the properties required for the specified use as indicated in Tables 1 through 6 in Section 9-33.2, the roll or rolls which were sampled will be rejected. Two additional rolls for each roll tested which failed from the lot previously tested will then be selected at random by the Engineer for sampling and retesting. If the retesting shows that any of the additional rolls tested do not meet the required properties, the entire lot will be rejected. If the test results from all the rolls retested meet the required properties, the entire lot minus the roll(s) which failed will be accepted.

All geotextile which has defects, deterioration, or damage, as determined by the Engineer, will also be rejected. All rejected geotextile shall be replaced at no expense to the Contracting Agency.

9-33.4(4) Acceptance by Certificate of Compliance

When the quantities of geotextile proposed for use in each geotextile application are less than or equal to the following amounts, acceptance shall be by Manufacturer's Certificate of Compliance:

Application	Geotextile Quantity
Underground Drainage	500 sq. meters
Soil Stabilization and Separation	1500 sq. meters
Permanent Erosion Control	1000 sq. meters
Temporary Silt Fence	All quantities

The Manufacturer's Certificate of Compliance shall include the following information about each geotextile roll to be used:

Manufacturer's name and current address,
Full product name,
Geotextile structure, including fiber/yarn type,
Geotextile roll number,
Proposed geotextile use(s), and
Certified test results.

9-33.4(5) Approval of Seams

If the geotextile seams are to be sewn in the field, the Contractor shall provide a section of sewn seam which can be sampled by the Engineer before the geotextile is installed.

The seam sewn for sampling shall be sewn using the same equipment and procedures as will be used to sew the production seams. If production seams will be sewn in both the machine and cross-machine directions, the Contractor must provide sewn seams for sampling which are oriented in both the machine and cross-machine directions. The seams sewn for sampling must be at least 2 meters in length in each geotextile direction. If the seams are sewn in the factory, the Engineer will obtain samples of the factory seam at random from any of the rolls to be used. The seam assembly description shall be submitted by the Contractor to the Engineer and will be included with the seam sample obtained for testing. This description shall include the seam type, stitch type, sewing thread type(s), and stitch density.

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