PART 2

Guidance on Specific Biological Assessment Topics

4.0 Components of a Biological Opinion

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4.0 Components of a Biological Opinion

A biological opinion is the document prepared by NOAA Fisheries or USFWS (referred to commonly as the Services) as part of the formal consultation process, to be issued at the culmination of this consultation process. This chapter provides a brief overview of the components of a biological opinion.

In general, a biological opinion is required when an action (e.g., construction activity) is estimated to adversely affect an ESA-listed plant or animal species. Depending upon the species in question, NOAA Fisheries or USFWS issues a biological opinion on the effects of the proposed action on the affected ESA-listed species. If the agency concludes that the species will be unaffected, the proposed action receives a *no-jeopardy* biological opinion and continues as planned. If the proposed action is found to *jeopardize* a species, the federal government may propose alternatives, require additional mitigation measures or deny the project. If the proponent can modify the project to align with proposed alternatives and/or satisfy the recommended mitigation requirements, the proposed action can proceed.

An example of a biological opinion outline is provided below. Though NOAA Fisheries and USFWS may organize their documents differently, and documents prepared by different regional offices of the same agency may also differ organizationally (see Tables 4.1 and 4.2), each of the sections typically included in a biological opinion is discussed in detail in this chapter:

- I. Consultation history
- II. Description of proposed action
- III. Description of action area
- IV. Status of species and critical habitat
    - A. Species and critical habitat description
    - B. Life history
    - C. Population dynamics
    - D. Status and distribution
    - E. Analysis of species and critical habitat likely to be affected
- V. Environmental baseline conditions
    - A. Status of species within the action area
    - B. Factors affecting species environment within the action area
- VI. Effects of the action
    - A. Factors to be considered
    - B. Analyses of effects of the action
    - C. Species response to the proposed action
- VII. Cumulative effects
- VIII. Conclusion
- IX. Reinitiation statement
- X. Reasonable and prudent alternatives (as appropriate)
- XI. Incidental *take* statement
    - A. Introductory paragraph
    - B. Amount or extent of *take* anticipated

C. Effect of the *take*
D. Reasonable and prudent measures (as appropriate)
E. Terms and conditions
XII. Conservation recommendations (as appropriate)
XIII. Literature cited

An example of a NOAA Fisheries or National Marine Fisheries Service outline is provided in Table 4.1 below.

Table 4.1. Example of NOAA or National Marine Fisheries Service outline.

NMFS BiOp
Introduction
Background and Consultation History
Description of Proposed Action
Action Area
Endangered Species Act
Biological Opinion
Status of the Species
Abundance / Status of ESU
Productivity /Status in Basin
Diversity and Spatial Structure / Status in Action Area by Subbasin
Status of Critical Habitat
Environmental Baseline
Conditions in Basin or Subbasin
Effects of the Action
Content varies: Discussion of Specific Effects to Species: Injury and Mortality, Behavioral Responses, Estimate of Extent of Exposure, etc.
Cumulative Effects
Conclusion
Reinitiation of Consultation
Incidental Take Statement
Amount or Extent of Take
Reasonable and Prudent Measures
Terms and Conditions
Conservation Recommendations
Magnuson Stevens Fishery Conservation and Management Act
Essential Fish Habitat Conservation Recommendations
Statutory Response Requirement
Supplemental Consultation
Data Quality Act Documentation and Pre-Dissemination Review
Literature Cited
Appendices

An example of a U.S. Fish and Wildlife Service outline is provided in Table 4.2 below.

Table 4.2. Example of a U.S. Fish and Wildlife Service outline.

USFWS BiOp
Consultation History
Biological Opinion
Description of the Proposed Action
Concurrence for Marbled Murrelet
Status of the Species
Listing Status
Current Status and Conservation Trends
Status of Recovery Unit(s)
Life History
Habitat Characteristics
Diet
Changes in Status of Recovery Unit(s)
Status of Critical Habitat
Legal Status
Conservation Role and Description of Critical Habitat
Current Condition Rangewide
Environmental Baseline
Description of the Action Area
Environmental Baseline in the Action Area
Status of the Species in the Action Area
Number and Distribution of Local Populations
Adult Abundance
Connectivity
Threats
Status of Critical Habitat in the Action Area
Effects of Past and Contemporaneous Actions
Effects of the Action
Insignificant and Discountable Effects
Adverse Effects of the Action
Content varies: Discussion of Specific Effects, Injury and Mortality, Behavioral Responses, Estimate of Extent of Exposure, etc.
Cumulative Effects
Conclusion
Incidental Take Statement
Amount or Extent of Take
Reasonable and Prudent Measures
Terms and Conditions
Conservation Recommendations
Reinitiation Notice
Literature Cited

4.1 Consultation History

This section of a biological opinion provides a brief overview of the consultation process. This section would describe any pre-consultation activities such as attendance at a pre-BA meeting or site visits, and identify when consultation was initiated, if the consultation period was extended, the date of reinitiation of consultation if applicable, whether additional information was requested and when it was received. This section also indicates that a complete administrative record of the consultation has been filed and where these files can be accessed.

4.2 Description of the Proposed Action

This section provides a detailed description of the proposed action: all primary and secondary construction elements, timing, equipment, impact minimization measures, etc. Essentially this section deconstructs the action into its constituent elements, explains how and when these elements will be implemented, and explicitly identifies what measures have and will be taken to minimize potential impacts.

4.3 Description of the Action Area

This section identifies the geographic extent of the action area and provides rationale for how the limits of the action area were determined. The action area envelops all areas that could sustain direct or indirect impacts associated with the proposed action as well as any interrelated or interdependent activities.

4.4 Status of Listed Species

This section provides an overview of the federal status of the listed species, identifies the delisting goals for species, and describes the conservation needs of the species (pertaining to habitat, behavior, and life history requirements).

This section also characterizes the federal status of designated critical habitats and describes the primary constituent elements of these habitats.

4.5 Environmental Baseline Conditions

This section of the biological opinion describes the environmental setting and environmental conditions within the action area. Often the section is divided into detailed descriptions of specific habitat components such as wetlands, riparian areas, upland areas, and developed areas.

The environmental baseline discussion describes the physical and biological characteristics of habitats in the action area generally and also as they pertain to particular species or life stages of species. This section also describes the history of disturbance to these habitats, what actions or developments have previously occurred and the relevance of the resulting environmental conditions on the status of listed species in the action area.

The status of species within the action area is summarized in this section, along with the conservation needs of the species within the action area. The environmental baseline discussion also characterizes habitat conditions within the action area as they pertain to designated critical habitats.

This environmental baseline information is critical for the effects analysis, because the response of species and critical habitats to a proposed action are in part determined by the conditions those species and habitats already face (the baseline).

4.6 Effects of the Action

This section provides a detailed analysis of the direct and indirect effects of the proposed action on listed species and any effects associated with interrelated and interdependent actions or activities. The analysis includes detailed exposure analysis, response analysis, and risk analysis for each of the species addressed in the biological opinion. The exposure analysis identifies the effects of the action that will likely overlap with species presence within the action area. The response analysis determines how listed species are likely to respond after exposure to these effects. The anticipated responses are based upon information in peer-reviewed literature, field studies, and reports from previous projects. The risk analysis determines the overall risk of the project for each listed species by comparing the exposure and response analyses.

This section also analyzes potential project impacts as they pertain to the primary constituent elements of designated critical habitats.

4.7 Cumulative Effects

The cumulative effects analysis is confined to the action area defined for the proposed project and assesses the effects of future state, tribal, local, or private actions that are reasonably certain to occur. This section of the biological opinion analyzes cumulative effects and assesses the risks to listed species and designated critical habitats that are associated with individual activities.

4.8 Conclusion

This section summarizes the analysis provided in previous sections of the biological opinion and concludes whether the proposed project would or would not jeopardize the continued existence of a listed species, and would or would not destroy or adversely modify designated critical habitat.

4.9 Incidental *Take* Statement

Section 9 of the Endangered Species Act and federal regulations issued pursuant to Section 4(d) of the ESA, prohibit *take* of endangered and threatened species, respectively, without a special exemption. An incidental *take* statement provides action agencies with an exemption from the taking prohibition, under Section 7(o)(2), as long as any taking meets the terms and conditions identified in the incidental take statement. The incidental *take* statement specifies the amount or extent of *take* that is authorized (i.e., number of individuals, period of time, extent of habitat or habitat surrogate), the effect of this *take* on the species, and reasonable and prudent measures that are necessary and appropriate to minimize incidental *take* of a listed species. These reasonable and prudent measures, if complied with, will ensure that taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking under the ESA.

4.10 Reasonable and Prudent Measures

Reasonable and prudent measures are non-discretionary measures to avoid or minimize take, that must be carried out by the action agency in order for the incidental take statement to apply. The draft reasonable and prudent measures are normally provide to the action agency for their review before the final incidental take statement is issued to ensure that they are in fact “reasonable” for the action agency to implement. The project biologist may be tasked with assisting the action agency during the review of these measures. The purpose of the review is to ensure that the measures are clearly described and fully understood by the action agency, and to ensure that their implementation is feasible. The action agency may determine modification of the draft measures is needed, and request the Services to make revisions. Once the action agency and the Services have agreed to the measures and they are incorporated into the final biological opinion, they are binding.

To implement each of the reasonable and prudent measures, specific terms and conditions are also identified by the Services in a separate section of the incidental take statement. Like the reasonable and prudent measures, the action agency must comply with these specific terms and conditions, to be exempt from the prohibitions of Section 9 of the ESA.

4.11 Terms and Conditions

The terms and conditions section provides nondiscretionary requirements that an action agency must implement in order to ensure their exemption from Section 9 prohibitions. Essentially the terms and conditions outline the specific steps that are necessary to ensure that each of the reasonable and prudent measures are successfully implemented.

The draft terms and conditions are normally provided to the action agency for their review to determine if modification or clarification is needed, before including them in the final biological opinion. The project biologist may be tasked with assisting the action agency during the review of the terms and conditions. This purpose of the review is to ensure that the measures are clearly described and fully understood by the action agency, and to ensure that their implementation is feasible. Once terms and conditions have been included in the final biological opinion, they are considered binding.

4.12 Conservation Recommendations

Conservation recommendations included in a biological opinion are discretionary action agency activities to further avoid or minimize adverse effects on listed species or critical habitat resulting from a proposed action, to help implement recovery plans or to develop information. The Services request that they be informed if and when the recommendations are implemented. Action agencies may or may not choose to implement the suggested conservation recommendations.

4.13 Reinitiation Notice

If the amount or extent of incidental *take* allowed in the incidental take statement is exceeded, the action agency must reinitiate consultation and provide an explanation of the causes of the taking. Specifically, the reinitiation notice informs federal agencies that they are required to reinitiate consultation with the Services if any of the following conditions apply:

- The amount or extent of incidental *take* is exceeded
- New information reveals potential effects of the agency action on listed species or critical habitat in a manner or to an extent not considered in this opinion
- The agency action is subsequently modified in a manner that results in an effect on the listed species or critical habitat not considered in this opinion
- A new species is listed, or critical habitat is designated, that may be affected by the action

4.14 Literature Cited

All of the personal communications and literature citations in the biological opinion are compiled into a standard reference list.

5.0 Endangered Species Act and Mitigation

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5.0 Endangered Species Act and Mitigation

Chapter Summary

- Under Section 7 of the Endangered Species Act, federal agencies are directed to use their authority to support ESA programs for the conservation of listed species and the habitats upon which these species depend.
- Recovery of species is not achieved on a project-by-project basis.
- Section 7 requires action agencies to minimize the level of *take* associated with each project by avoiding or minimizing project impacts to species and habitats.
- There is no requirement that action agencies mitigate for incidental *take*.
- For projects undergoing formal consultation, the addition of mitigation to a project cannot result in an informal consultation. If *take* will occur, the project requires formal consultation.
- The Services cannot require major changes to projects, and any suggested changes to projects should be directly associated with anticipated impacts.
- The Washington Department of Fish and Wildlife has the authority under the hydraulics code to require mitigation for the protection of fish life.
- The U.S. Army Corps of Engineers has the authority to require mitigation of wetland impacts.
- Local agencies have the authority to require mitigation of wetland and stream impacts in accordance with their critical area ordinances.

5.1 Purpose of the Endangered Species Act

The purpose of the Endangered Species Act is to provide a means whereby the ecosystems upon which threatened and endangered species depend may be conserved, and to provide a program for the conservation of such species. Under Section 7(a)(1) of the ESA, federal agencies are directed to utilize their authorities in furtherance of the purpose of this act by carrying out programs for the conservation of listed species.

5.2 Federal Agencies and Washington State Department of Transportation Programs to Support the Recovery of Listed Species

The Washington State Department of Transportation supports a fish passage replacement program within the agency. Under this multimillion-dollar program, numerous fish passage barriers are replaced each year. Replacements are prioritized according to their level of benefit to fish. In 2002, WSDOT also established a collaborative process with Washington Department of Fish and Wildlife (WDFW) to address chronic environmental deficiencies (CED); locations along the state highway system where recent, frequent, and chronic maintenance and/or repairs to the state transportation infrastructure are causing impacts to fish and/or fish habitat. This program strives to develop long-term solutions for these problem areas. Additional information on both of these programs is available at <http://www.wsdot.wa.gov/Environment/Biology/FP/fishpassage.htm> and at <http://www.wsdot.wa.gov/Environment/Biology/FP/CEDretrofits.htm>.

WSDOT also actively supports research that contributes information useful to recover listed species. Among them are a statewide habitat connectivity assessment and a multi-pronged research effort to understand habitat connectivity east of Snoqualmie Pass, evaluating the effects of ferry docks on fish migration, evaluating and minimizing noise impacts to aquatic species from pile installation, and establishing the fish passage requirements of juvenile salmonids. Additional information on the Environmental Research program is available at: <http://www.wsdot.wa.gov/research/>.

FHWA has supported numerous studies, conferences, and projects focused on habitat connectivity, fish passage programs and standards, wetland restoration, and other environmental programs.

Neither agency supports recovering listed species on a project-by-project basis through Section 7 consultations.

5.3 The Section 7 Consultation Process

Under the Section 7 consultation process, the action agency is required to make an *effect determination*, that is, to determine the effect the project will have on a listed species. Section 7 requires action agencies to minimize the level of *take* associated with each project. There is no requirement that the action agency mitigate for incidental *take*. In this regard, ESA is different from other environmental regulations such as wetland regulations, which require mitigation for impacts.

However, the concepts of avoidance and minimization of impacts are important parts of project planning and implementation, playing a large role in the determination of effect. For example, if a project occurs during the sensitive nesting season and is out of sight of a spotted owl nest site or an occupied marbled murrelet nest stand but will use heavy equipment within 35 yards of the nest site or stand, the project will result in an adverse effect on the species and therefore will require formal consultation. The same is true for a project that will complete in-water work while listed fish species are present.

However, if the project is timed to occur outside the sensitive nesting season or the migration period when fish are likely to be present, the effect determination will be NLTAA. This effect call allows the project to undergo the shorter informal consultation process. In these examples, it may not be possible to have a no effect call because the owls tend to be present year round, murrelets may visit their nesting stand throughout the year, and both species may elect to alter their behaviors during the project.

Unfortunately, there are circumstances when an adverse effect call must be made and the project must undergo formal consultation. Examples include long-term projects (e.g., a bridge replacement) or weather-dependent projects that are unable to avoid the sensitive nesting period. This is often the case for projects that require in-water work in waters that contain rearing steelhead or Chinook and where there is suitable rearing habitat in the project area. It is not possible to mitigate an adverse effect call down to a NLTAA call. If fish will be harassed by the in-water work or caught in nets and moved out of the work area, this meets the definition of *take*, and performing mitigation (such as replanting a riparian corridor or replacing a fish passage barrier) will not prevent take (prevent fish from being harassed or possibly harmed while being moved).

5.4 What the Services Can Require

When a proposed project is determined to have an adverse effect on listed species, the Services issue a biological opinion that may include reasonable and prudent measures that are mandatory and must be carried out by the action agency. These measures serve to minimize impacts on specific individuals or habitat affected by the action. The required measures should be developed in conjunction with the action agency and the applicant to ensure that they are reasonable, will result in only minor changes to the project, and are within the legal authority and jurisdiction of the agency to implement.

Reasonable and prudent measures may include narrowing the right-of-way to be disturbed, moving the location of temporary storage areas, or changing the scope, duration, and timing of the project.

Examples of unreasonable measures include asking a federal agency to implement a local county's riparian buffer protection ordinance, asking the applicant to make modifications to the property of another individual or agency, or asking the applicant to complete a research project on the life history and habitat utilization of a listed species.

5.5 Agencies with the Authority to Require Mitigation

The Washington Department of Fish and Wildlife has the authority under the hydraulics code to require mitigation for the protection of fish life. A hydraulic project approval (HPA) permit is required for work occurring within waters of the state. The habitat biologist issuing the permit determines what the mitigation will be, and it can include the correction of fish passage barriers, revegetation of stream banks disturbed during construction, or placement of large woody debris. If an HPA is required for a project, and mitigation is required as part of the HPA, then the mitigation becomes part of the project, and the impacts of the mitigation on listed species must be addressed in the BA.

In addition, local agencies can require mitigation for wetland and stream impacts in accordance with their critical areas ordinances. The U.S. Army Corps of Engineers also can require mitigation for wetland impacts. The mitigation becomes part of the project, and the effects of completing the mitigation must be addressed in the BA. The mitigation does not occur as a requirement of ESA; rather, it occurs as part of the project.

5.6 Mitigation Under the Endangered Species Act

Sometimes agencies add mitigation to a project because of suggestions by the Services that unless the mitigation is completed, the project will need to undergo formal consultation (which is a very long process). In some cases it may be appropriate to make the suggested changes to a project, but in many cases it is not. Examples of suitable suggested changes include altering project timing to avoid or minimize impacts on species, or revegetating a stream bank that was disturbed by construction. Examples of unsuitable suggested changes include purchasing a conservation easement on a mile of stream bank to keep a riparian corridor intact, completing research on a species, and using soft structure methods to control bank or bridge scour that will result in compromising the safety of the structure or the traveling public. The Services cannot require major changes to projects, and any suggested changes to projects should be directly associated with anticipated impacts of the project. The action agency must recognize that the consultation process, whether formal or informal, is based on the effect call for a project.

5.7 Why Action Agencies Should Help to Recover Listed Species

Agencies should do what they can to help recover listed species. While restoration and enhancement activities should not be performed as mitigation for Section 7 consultations, they should be implemented where possible as part of the project. For example, when a paving or safety improvement project crosses a stream with a culvert that is a documented fish passage barrier, that culvert should be replaced as part of the project. The rationale for completing the project this way is that the barrier needs to be removed, and while the replacement may be scheduled for a later date, it is easier to do it as part of the proposed project as the equipment is already in place, and the new pavement will not be compromised in the future. The project is submitted to the Services with the fish passage barrier replacement as part of the project, not as mitigation for the project.

6.0 Impact Avoidance and Minimization Measures

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6.0 Impact Avoidance and Minimization Measures

Chapter Summary

- Performance standards are observable or measurable benchmarks for a particular performance objective against which a project can be compared. If the standards are met the related performance objectives are considered to have been fully achieved. Performance measures must be something quantifiable; measures, not actions that are: 1) achievable and 2) capable of being monitored. Performance standards may only be applied on some projects.
- Performance standards are often established for projects lacking detailed designs (i.e., projects undertaking consultation early in design). Examples of Performance standards are provided below:
  - Performance Measure or Goal #1. Minimize harm and harassment to listed salmonid species due to degradation of water quality during in-water work activities.
    - Performance Standard #1.1. Water quality in the Puyallup River will meet the State's Water Quality Standard at a point 300 feet downstream during in water work as determined by a monitoring program. If an activity results in non-compliance with this standard, work causing the effect will be immediately stopped and corrective actions taken.
- Conservation measures are activities or measures that help recover listed species. Conservation measures may only be identified or recommended for some projects.
  - An example of a conservation measure would include implementing research or surveys of unsurveyed habitat in other portions of a watershed or other areas in a species' range to determine occupancy, life history information, etc. or contribution of funds toward habitat enhancement projects intended to improve baseline conditions for a particular species.
- Minimization measures (MMs) are measures that reduce the impact of a project on listed species or habitats. Minimization measures can be precautionary measures implemented by the federal action agency to minimize or eliminate project effects on listed and sensitive species and habitat, or they can include avoidance and preservation measures such as timing restrictions or buffers around sensitive habitat types and habitat

features that are important to sensitive species. Minimization measures apply to all projects.

- Best management practices (BMPs) are methods, facilities, built elements, and techniques implemented or installed during project construction to reduce short- and long-term project impacts on listed and sensitive species and habitat. BMPs are applied for all projects.

- Minimization measures and BMPs are measures that are considered part of the proposed action that will be implemented. They are not recommendations or suggestions.

- MMs and BMPs can be defined to minimize impacts associated with specific project activities or techniques.

  - Examples of activity-specific measures include erosion control features for earthwork activities (BMP), replanting of areas where vegetation removal or grading has occurred (MM), infiltration features for stormwater runoff in projects adding new impervious surface area (BMP), and mitigation plans for wetland impacts (MM).

- MMs and BMPs can be defined to minimize potential impacts on species and habitat.

  - Examples of habitat- or species-specific measures include timing restrictions (MM), exclusion of listed species from the work area (MM), noise shields (BMP), and avoiding riparian vegetation removal (MM).

- MMs and BMPs should be compiled into the Impact Avoidance and Minimization section of the BA. This section should include MMs and BMPS addressing specific construction elements, as well as impact minimization measures for particular species and critical or suitable habitats.

- MMs and BMPs that are consistent with WSDOT standard specifications can be easily incorporated into project contract documents.

- MMs and BMPs that are not consistent with WSDOT standard specifications must be incorporated as special provisions into contract documents. The project biologist should coordinate with project designers and engineers to ensure that these additional provisions are feasible. The project biologist should work with project designers to ensure that special provisions are incorporated into contract documents.

This chapter defines and explains minimization measures (MMs) and best management practices (BMPs) and explains where to discuss them within a BA. The chapter provides an overview of common construction activities for which impact minimization measures may be required, general considerations for developing appropriate impact minimization measures for construction activities, guidance for developing impact minimization measures for sensitive species and habitats, and examples of appropriate enforceable wording for MMs and BMPs extracted from BAs.

The chapter is organized as follows:

- The first section of the chapter defines MMs and BMPs and discusses the differences between them.

- The second section explains where a project biologist should include discussions of MMs or BMPs within a BA, as well as two preferred options for compiling these impact minimization measures to facilitate federal review of the BA and also to facilitate incorporation of the required measures into the contracts administered for a project.

- The third section provides an overview of construction activities that may require impact minimization measures, followed by a more detailed discussion of three specific project activity types. This discussion outlines general considerations for assessing impacts and appropriate ways to minimize these impacts. The last subsection provides examples of MMs and BMPs that address in-water work impacts, and includes a BA excerpt that illustrates how one project biologist defined specific project activities, associated impacts, and specific impact minimization measures.

- The fourth section discusses the importance of considering additional species- and habitat-specific impact minimization measures. The first subsection addresses MMs for particular species and illustrates, in a BA excerpt, the timing restrictions developed for one project. The second subsection addresses MMs and BMPs for minimizing impacts on sensitive habitats. Examples of specific MMs and BMPs are provided for sensitive aquatic and terrestrial habitats.

6.1 Impact Minimization Measures and Best Management Practices

MMs and BMPs are precautionary measures intended to minimize environmental impacts associated with proposed project activities or elements. These measures can target impacts associated with specific project activities or techniques, as well as potential impacts on species and habitat. MMs and BMPs are not merely recommendations; they are measures included in the proposed action, to be implemented throughout project planning, design, and construction in order to minimize environmental impacts. The Services cannot consult on recommendations, only known project elements or measures that will be implemented.

MMs are most frequently avoidance or preservation measures of some kind, for example, timing restrictions or buffers around sensitive habitat types and habitat features that are important to sensitive species. BMPs are methods, facilities, built elements, and techniques implemented or installed during project construction to reduce short- and long-term project impacts. The nature of MMs and BMPs vary according to physical and environmental conditions of the project site, different phases of the project, and the activities for which they are intended. MMs and BMPs are developed for implementation during the permitting, design, and construction phases of projects.

Typically, the BA is developed concurrently with the design of a new project. During this process, it is critical for the biologist writing the BA and engineers designing the project to stay in close communication throughout preliminary and final design. The project biologist relies on the design engineers for accurate project description detail (e.g., project areas and construction techniques). Based on this information, it is the biologist’s responsibility to identify MMs and BMPs for the project in conjunction with the design and project engineers. The project engineer must approve all of the MMs and BMPS to ensure that the MMs and BMPs can be implemented and are included in the contract.

MMs and BMPs are effective only if they are clearly communicated to the contractor responsible for construction of the project. To construct a project, the contractor relies entirely on the construction plan sheets, WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT 2004a), and supplemental special provisions. Some MMs and BMPs are partially or wholly covered in the standard specifications, but many are not and need to be incorporated by the design engineers into the construction plan sheets and the special provisions. Some MMs are conditions attached to permits, such as a Clean Water Act Section 404 permit, a Section 401 water quality certification, or a hydraulic project approval. All permits must be attached to the construction plans and referred to in the special provisions so that the contractor is familiar with them. To the extent possible, these permit conditions should be specified in the special provisions.

After the BA receives concurrence from the Services, all MMs and BMPs need to be finalized in the construction plans and special provisions. After final design, the construction plans and special provisions are advertised so that contractors can bid on the project. The contractor selected for the project is responsible to carry out only what is specified in construction plans, standard specifications, and special provisions. For this reason, it is critical that all necessary MMs and BMPs are clearly described in the BA. If they are missing or unclear, there is a risk that the contractor may perform activities that harass threatened or endangered species, damage critical habitat, or damage suitable habitat for listed species.

The following sections of this chapter contain many examples of MMs and BMPs that have been used on projects in the past and are currently used for projects that comply with the

Programmatic Biological Assessment for the Washington State Department of Transportation Eastern Washington Regions – Working Document (WSDOT 2004b), and the *No Effect and Not Likely to Adversely Affect Programmatic Biological Assessment Working Document for NOAA Fisheries Listed Species* (WSDOT 2002).

6.2 Where to Include Minimization Measures and Best Management Practices within a BA

MMs and BMPs should be compiled into a single section of the BA that includes measures addressing specific construction elements as well as impact minimization measures for particular species and critical or suitable habitats. Activity-specific measures are usually defined first in the BA development process, then species- or habitat-specific measures are defined later.

If the general term *BMPs* is used in a BA, the specific impact-minimization activities intended by the project biologist in using this term should be described in the report, so that the Services understand the exact measures that will be taken to reduce potential project impacts. For example, if a BA states, "during construction, BMPs will be implemented to ensure that impacts on the adjacent stream are minimized," the project biologist should describe these practices in detail (e.g., all disturbed areas will be replanted or reseeded within 30 days).

Because impact minimization measures can be included in two distinct sections of a BA, it is important to compile all of these measures in a single location, for two reasons: 1) to facilitate review of the final effect determinations and their rationale, and 2) to ensure that all measures identified in a BA are clearly specified in documents conveyed to the contractor implementing the project. A compilation of impact minimization measures can be effectively provided in a list of all impact minimization measures identified in the report (activity-specific, as well as species- or habitat-specific), to be included in the Impact Avoidance and Minimization Measures section of the BA.

6.3 Developing Appropriate Impact Minimization Measures for Specific Construction Activities

6.3.1 Overview of Common Construction Activities

Some of the most common activities associated with construction and operation of transportation projects include the following:

- Grading, cutting, or filling
- Vegetation removal or clearing
- In-water work activities
- Highway runoff treatment

- Activities that increase the timing and duration of noise above ambient levels (e.g., pile driving and blasting)
- Sediment removal
- Road, bypass, or interchange construction and maintenance
- Pavement patching, repair, painting, and crack sealing
- Sweeping or cleaning
- Guardrail installation
- Slope repair
- Shoulder widening
- Roadside landscaping
- Ditch or channel maintenance
- Wetland mitigation
- Riparian revegetation or restoration
- Culvert and inlet repair, replacement, extension, or installation
- Stream bank stabilization
- Bridge removal and construction, structural bridge repair, and scour repair
- Debris removal or relocation
- Bioswale construction

6.3.2 General Considerations for Minimizing Activity-Specific Impacts

Two of the most common transportation-related construction activities listed above are discussed below in more detail (grading, cutting, or filling; and vegetation removal). These examples illustrate types of impacts and general impact minimization approaches a project biologist might consider in selecting specific MMs and BMPs for the proposed project. A similar list of impacts and general impact-minimizing measures or practices could be developed for any of the specific activities listed above.

6.3.2.1 Grading, Cutting, or Filling

To adequately address earthwork activities (grading, cutting, and filling) in a BA, the extent of these activities should be quantified. Specific details should be provided regarding the size and type of fill to be placed, the location of fill in relation to nearby water resources, the methods and locations of soil removal and disposal, and methods of soil stabilization after grading or filling is complete. The placement of fill or the disturbance soils within areas containing salmon-bearing streams can have several impacts, including but not limited to the following:

- Introduction of additional impervious or semi-impervious surface area to the riparian system
- Introduction of additional potentially erodable materials to the system
- Alteration of hydrodynamics within the system
- Suspension of sediments in nearby water bodies.

Some examples of general approaches that might be considered to minimize impacts associated with projects requiring grading and filling activities include but are not limited to the following:

- Placement of a no-construction buffer around wetlands and sensitive riparian habitats
- Avoidance of grading or placement of fill adjacent to fish-bearing streams or wetlands
- Straw placement, hydroseeding, or planting of newly disturbed sites to minimize erosion
- Placement of erosion control features (e.g., hay bales or silt fences) surrounding newly disturbed or filled sites.

The following examples of MMs developed for projects requiring filling illustrate how to word MMs appropriately:

MM 1. Fill material shall be placed, not randomly dumped.

The intent of this MM is to minimize impacts on sensitive fish habitat within streams and rivers associated with placement of rock for filling scour holes or making barbs. To ensure that rock is carefully placed in streams and rivers, the design should incorporate language similar to the following within the site work sections of the special provisions: Contractor will place rock by hand or employ machine placement in areas designated in the drawings.

MM 2. Temporary fills must be entirely removed and the site restored to preexisting conditions.

The intent of this MM is to ensure that temporary fills are removed and the site is restored so that potential impacts on sensitive areas (such as erosion and sedimentation, changes in drainage paths, compaction, settlement, etc.) are not permanent.

This MM is not specifically addressed in the standard specifications and should be incorporated into construction plans and special provisions. For example, if a temporary access road is placed in a wetland, instructions should be provided for the contractor to remove all road materials and restore the area (i.e., restore soils and native vegetation).

If soil compaction is an issue, the contractor could be required to decompact affected areas by ripping to a depth of at least 12 inches, regrading, and recompacting to a specified maximum density. This is most important where the work includes plantings, because root growth is inhibited by densely compacted soils. To define acceptable levels of density and compaction limits, it is prudent to obtain a sample of the site soils and perform laboratory testing to determine the moisture-density relationship. Otherwise, a conservative specification for the compaction limit is 85 percent of the soil's maximum dry density as determined by test method ASTM D698.

6.3.2.2 Vegetation Removal and Clearing

To adequately address vegetation removal or clearing activities, the BA should quantify the extent of vegetation removal and clearing activities proposed for each phase of the project, or for the project as a whole. The trees to be removed as part of a project also should be quantified in terms of acreage or number of trees, and described by species and diameter-at-breast-height (dbh) class, if possible. If riparian vegetation is removed as part of the proposed action, the amount and type of riparian vegetation to be removed should be measured, and its stream shading, bank stabilization, and food web contribution functions should be assessed. For wetland vegetation to be removed, the area should be quantified, and the ecological functions (as they relate to listed species) lost as a result should be considered in the assessment of project impacts.

The general impacts associated with vegetation removal or clearing activities include but are not limited to the following:

- Removal of trees (indicate whether they are suitable or unsuitable habitat)
- Removal of riparian vegetation
- Wetland impacts
- Introduction of noxious weeds or exotic species
- Ground or soil disturbance or compaction
- Increased bank or soil erosion
- Sedimentation
- Noise impacts

- Human presence or activity impacts
- Impacts on prey species.

Some general approaches that the project biologist might consider to minimize impacts associated with these activities include the following:

- Where riparian vegetation has been removed from aquatic resources, isolate disturbed areas using erosion control features (such as silt fencing or hay bales) until disturbed areas are stabilized or revegetated
- Replant areas with native vegetation, or hydroseed disturbed sites, to prevent soil erosion
- Cut vegetation at the ground surface rather than grubbing, which removes the roots.

The following examples of MMs developed for projects requiring vegetation removal illustrate how to word MMs appropriately:

MM 3. Boundaries of clearing limits associated with site access and construction limits will be flagged to prevent ground disturbance outside the limits.

The intent of this MM is to confine work activities to nonsensitive areas, or minimize the amount of disturbance in sensitive areas.

There is language within the standard specifications that covers this in general.[1] *However, the drawings still must clearly depict the areas to be protected. If it is critical, the drawings and special provisions should include a requirement for the contractor to delineate these areas using temporary high-visibility fencing.*

To ensure that unintended disturbance does not occur in sensitive areas, the design should incorporate language similar to the following within the

1. Section 1-07.16 of the standard specifications – *Protection and Restoration of 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. . . . If the engineer requests in writing, or if otherwise necessary, the contractor shall install protection, acceptable to the engineer, for property (land, utilities, trees, landscaping, … and other property of all description whether shown on the plans or not).*

Section 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.*

In Section 2-01.1, the areas to be cleared and grubbed are limited by the following statement: *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, and other objects to remain.*

Section 2-01.3(1) – *Clearing: The contractor shall protect, by fencing if necessary, all trees or native growth from any damage caused by construction operations.*

site work sections of the special provisions: "Contractor will install temporary high-visibility fencing to demarcate and protect sensitive areas. No work, including placement or stockpiling of fill materials, will be performed within these areas. When it is no longer needed, or at the engineer's direction, contractor will completely remove and dispose of temporary high-visibility fencing."

The sensitive areas should also be delineated on the drawings, along with a note containing a similar statement regarding installation of high-visibility fencing and the need to protect these areas.

Because the standard specifications do not include installation or material requirements for temporary high-visibility fencing, the designer should include provisions for temporary high-visibility fencing installation and materials.

MM 4. Vegetation will be grubbed only from areas undergoing permanent alteration. No grubbing will occur in areas slated for temporary clearing followed by revegetation.

The intent of this MM is to minimize disturbance and to allow vegetation to grow back in temporary impact areas.

See comment for MM 3.[2]

MM 5. Disturbed areas will be restored to pre-project conditions, using native plant species that are endemic to the project vicinity or region.

The intent of this MM is to ensure that areas temporarily disturbed are adequately restored.

For areas that are designated to not be disturbed, their restoration is covered in the standard specifications.[3] *These areas should be specifically delineated on the drawings (see above comments). However, for areas disturbed in the course of the work, this MM is not specifically addressed in the standard specifications. The construction drawings and special provisions should incorporate appropriate restoration requirements for each disturbed area. This may include a planting plan that identifies each location and native plant species to be planted in disturbed or temporary impact areas.*

To ensure that plants successfully mature, a monitoring and maintenance plan should be implemented after construction. The standard

2. Section 2-01.3(2) of the standard specifications – *Grubbing: The contractor shall grub all areas indicated by the engineer or by the special provisions.*

3. Section 1-07.16(1), 4th paragraph: *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.*

specifications have a requirement for plant establishment.[4] *However, if desired, the designer should incorporate any critical or special procedures, as required by permit conditions, for monitoring after construction, submitting monitoring reports to permitting agencies, and implementing maintenance measures, as necessary.*

MM 6. Removal of riparian vegetation will be minimized to the greatest extent possible. Native riparian vegetation will be replanted where feasible. Vegetation restoration will be coordinated with [insert the appropriate agency name].

The intent of this MM is to minimize impacts on riparian areas.

This MM is addressed in the previously noted sections of the standard specifications, but without specific reference to riparian habitat. Although the standards list WDFW requirements for replanting stream bank or shoreline plants that are disturbed,[5] *the requirement to minimize impacts on riparian areas is not specifically addressed in the standard specifications.*

This MM should be incorporated into the construction plans and special provisions by clearly designating where vegetation will be preserved (see MM 3) in riparian areas. In addition, this MM should be incorporated into the planting plans by designating the locations and species of native plants to be planted in riparian areas.

6.3.3 In-Water Work: Impact Minimization Approaches

6.3.3.1 General Considerations for In-Water Work

In-water work activities include but are not limited to pile installation, bank stabilization, pile removal, bridgework, stream or ditch realignment work, and culvert replacement. The construction methods or techniques employed in each of these activities have impacts that are unique to their application. Common impacts include sedimentation, impacts on substrate (spawning beds and cover), and direct mortality of fish.

In-water work methods and their impacts should be carefully researched and described by the project biologist. A BA should document the specific construction techniques, materials, and impacts of the proposed action in relation to the listed species and habitats occurring in the

4. Section 8-02.3(13) – *Plant Establishment*: *Plant establishment shall consist of caring for all plants planted on the project and caring for the planting areas within the project limits*. This section also requires that the contractor prepare and submit a *first year plant establishment plan* for approval.

5. Section 1-07.5(2) of the standard specifications – *State Department of Fish and Wildlife: The contractor shall 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.*

project action area. To minimize these impacts, MMs tailored to the construction methods must be developed and included in the BA. This topic is discussed more completely in PART 2, IN-WATER WORK.

General approaches that should be considered by the project biologist to minimize impacts of in-water activities include but are not limited to the following:

- Avoid in-water work if feasible, or conduct it only during approved in-water work windows.
- Divert streamflow during in-water work to minimize turbidity.
- Use bioengineered solutions where feasible.
- Perform work during low flow or dry conditions, or during dry weather.
- Isolate the area of in-water work from the water body to minimize sediment impacts (using cofferdams, silt fencing, hay bales, or water sausages), and pump sediment-laden waters to an infiltration or treatment site.
- Isolate the work area to avoid impacts on listed fish species, and remove fish from the area if necessary (using seining, netting, and as a last resort, electrofishing). WSDOT now has a fish handling protocol that has been approved by the Services.
- Dispose of debris or sediments outside the floodplain.
- Clean the activity site after construction to prevent an influx of sediments to streams after the first large storm event.
- Minimize impacts on stream banks and riparian vegetation.

6.3.3.2 Examples of MMs and BMPs: In-Water Work

The following examples of MMs and BMPs developed for projects requiring in-water work illustrate how to word MMs or BMPs appropriately:

MM 7. Work below the ordinary high water mark (OHWM) will be conducted during the in-water work window listed in the hydraulic project approval (HPA) issued by WDFW and approved by USFWS and NOAA Fisheries.

The intent of this MM is to avoid impacts on fish when they are most likely to be present in a natural water body where work is proposed.

This particular MM is covered in a very general way by the standard specifications.[6]

Seasonal restrictions on work in water bodies are rules that WDFW adds as conditions in HPAs. These seasonal restrictions need to be incorporated into the special provisions.

MM 8. Either the in-water work area will be isolated from the rest of the water body and surrounding riparian areas, or flows will be diverted around the area of construction using appropriate features (e.g., filtration fencing, water sausages, or cofferdams).

The intent of this MM is to avoid or minimize turbidity impacts on fish and habitat downstream of the construction area.

The standard specifications have provisions that cover the intent of this MM.[7] *The designer should review these requirements and augment as necessary within the special provisions.*

MM 9. Work will not inhibit passage of any adult or juvenile salmonid species throughout the construction period or after project completion.

The intent of this MM is to avoid interfering with the migration and rearing activities of salmonids.

Because the standard specifications do not allow for blocked fish passage, an HPA permit is necessary to override this specification. Conditions of the HPA should be referenced in the special provisions.

MM 10. All concrete will be poured in the dry, or within confined waters not connected to surface waters, and will be allowed to cure a minimum of 7 days before contact with surface water.

The intent of this MM is to prevent concrete from increasing the pH of natural water bodies by allowing concrete to fully cure prior to contact with water.

The standard specifications cover placement and curing of concrete from a quality control standpoint rather than an environmental protection

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6. Section 1-07.5(1) of the standard specifications – *General – Fish and Wildlife and Ecology Regulations: Throughout the work, the contractor shall comply with all current rules of the state Departments of Fish and Wildlife, and Ecology.*

7. Section 1-07.5(2) of the standard specifications – *State Department of Fish and Wildlife: The contractor shall never block stream flow or fish passage.*

Section 2-09.3(3)A – *Preservation of Channel*: *When foundations or substructures are built in or next to running streams, the contractor shall excavate inside cofferdams, caissons, or sheet piling unless dredging or open pit excavation is permitted. Contractor shall never disturb the natural stream bed next to structure.*

standpoint.[8] However, there is a provision that prohibits discharge to the environment of water used for curing.[9]

The standard specifications do not indicate the minimum time necessary before concrete can contact surface water. This information should be added to the special provisions. For additional protection, the designer should consider requirements for rinsing the freshly cured concrete prior to allowing it come into contact with surface waters.

MM 11. Sediment-laden water generated during construction will be pumped to an infiltration site or to an upland settling area, where it is subsequently treated and sediments are consolidated prior to returning water to streams. Sediments will then be removed and disposed of in accordance within Washington Department of Ecology requirements. Discharge of water back to streams will occur in such a manner as not to cause erosion.

The intent of this MM is to protect streams from turbidity impacts associated with sediment-laden runoff.

The standard specifications generally prevent the discharge into state waters of any material that contains sediment.[10] Additional specific requirements for water pollution control are found in Section 8-01 Erosion Control and Water Pollution Control.[11] Ground water encountered within excavations shall be treated before being discharged.[12]

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8. Section 6-02.3(6) – *Placing Concrete*: *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.*

9. Section 6-02.3(11) – *Curing Concrete*: *Concrete shall cure for a minimum of 3 days and as long as 14 days depending on the type of concrete and curing method. Water used to cure the concrete shall not be allowed to run off and enter any lakes, streams, or other surface waters.*

10. Section 1-07.5(3)4 of the standard specifications: *Dispose of, in ways that will prevent their entry into state waters, all toxicants (creosote, oil, cement, concrete, and equipment wash water) and debris, overburden, and other waste materials.*

11. Section 8-01.3(1): *Controlling pollution, erosion, runoff, and related damage requires 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.*

12. Section 8-01.3(1) C: *When ground water is encountered in an excavation, it shall be treated and discharged as follows:*
1) When the ground water meets state water quality standards, it may bypass detention and treatment facilities and be rerouted directly to its normal discharge point at a rate and method that will not cause erosion.

2) When the turbidity of the ground water is similar to the turbidity of the site runoff, the ground water may be treated using the same detention and treatment facilities being used to treat the site runoff, and then discharged at a rate that will not cause erosion.

Otherwise, this MM is not specifically addressed in the standard specifications. If a project site has a viable upland area for treatment or infiltration, this MM should be incorporated into the special provisions and design drawings as an option. The designer should also pay attention to the physical nature of the sediment/turbidity to determine the feasibility of settlement as a treatment method. The contractor also may prefer to use other treatment methods.

MM 12. All culvert replacements and fishways will be designed in accordance with the WDFW *Design of Road Culverts for Fish Passage* (WDFW 2003) and *Fishway Design Guidelines* (WDFW 1992).

The intent of this MM is to provide culverts that are fish-passable during all seasons of the year.

Typically, culvert design is performed by the designer and fully incorporated into the contract drawings and special provisions, in which case this MM does not pertain to the contractor. In the case of temporary culverts installed for diversions or other purposes, the design may or may not be performed by the contractor. If the contractor performs culvert design, this MM should be incorporated into construction plans and special provisions and approved by WDFW in the HPA permit.

MM 13. Prior to entering the water, all equipment will be checked for leaks and completely cleaned of any external petroleum products, hydraulic fluid, coolants, and other deleterious materials. Washwater will not be discharged to any water body without pretreatment to state water quality standards.

The intent of this MM is to prevent pollutants from entering natural water bodies and affecting fish or habitat.

The standard specifications provide general requirements to prevent pollutants from entering state waters,[13] *along with two specific*

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3) When the turbidity is worse than the turbidity of the site runoff, the ground water shall be treated separately until the turbidity is similar to or better than the site runoff before the two may be combined and treated, using the same detention and treatment facilities being used to treat the site runoff, and then discharged at a rate that will not cause erosion.

13. Section 1-07.5(2) of the standard specifications – *State Department of Fish and Wildlife: The contractor shall not degrade water in a way that would harm fish. (Criteria: Washington state water quality regulations.)*

requirements for keeping equipment out of state waters[14] *and preventing the discharge of equipment washwater into state waters.*[15]

However, if in-water work is to be conducted, the special provisions should be augmented to require that the contractor inspect equipment for leaks and faulty parts (especially hydraulic lines, fittings, and cylinders) and clean the equipment each day or shift that the equipment is to enter the water. Additionally, the designer should add language to the special provisions to require that all equipment operating in state waters contain biodegradable, nontoxic, vegetable-based hydraulic oil rather than petroleum-based hydraulic oil.

MM 14. All equipment entering waters containing bull trout will use vegetable oil or other biodegradable, acceptable hydraulic fluid substitute.

The intent of this MM is to prevent hydraulic fluid spilling into and polluting natural water bodies in the event of an accidental release due to equipment leakage or hydraulic component failure.

This MM is not addressed in the standard specifications and should be incorporated into construction plans and special provisions (see comments under MM 13).

MM 15. Culvert cleaning and repair will occur in the dry or when listed or proposed fish are not likely to be present.

The intent of this MM is to avoid disturbance to fish in the vicinity of culverts during cleaning and repair activities.

Culvert cleaning MMs are not addressed in the standard specifications. If culvert cleaning is included in a contract, this MM language should be incorporated into the special provisions.

MM 16. Every effort will be made to perform culvert cleaning activities from the top of the bank.

The intent and implementation of this MM is similar to MM 15. This MM is not addressed in the standard specifications and should be included in the special provisions as necessary (see the comments under MMs 13, 14, and 15).

14. Section 1-07.5(2)7: *Keep all equipment out of any flowing stream or other body of water, except as may be permitted by the special provisions.*

15. Section 1-07.5(3) – *State Department of Ecology*: *In doing the work, the contractor shall … dispose of, in ways that will prevent their entry into state waters, all … equipment wash water….*

MM 17. Every effort will be made to install riprap and other materials from the banks or outside the wetted perimeter.

The intent of this MM is to minimize disturbance to fish and habitat within natural water bodies.

This MM is not addressed in the standard specifications and should be incorporated into construction plans and special provisions, as necessary.

MM 18. All materials (such as riprap) placed within the water will be prewashed to remove sediment and other contaminants.

The intent of this MM is to prevent pollutants from entering natural water bodies and affecting fish or habitat.

This MM is not addressed in the standard specifications and should be incorporated into construction plans and special provisions.

MM 19. All dredged or excavated materials will be removed to an upland location where they cannot enter any water body.

The intent of this MM is to prevent pollutants such as sediments or contaminated sediments from entering water bodies and affecting fish or habitat.

The standard specifications have a few requirements that may meet the intent of this MM,[16] *although the specific location of upland disposal is not covered. Specific details related to this MM should be incorporated into construction plans and special provisions.*

MM 20. Construction barges will not be beached.

The intent of this MM is to prevent barge-related impacts on beach substrates and vegetation.

While the standard specifications require the contractor to submit a plan detailing barge locations used for some activities,[17] *this does not fulfill the*

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16. Section 1-07.5(2) of the standard specifications – *State Department of Fish and Wildlife*: *The contractor shall dispose of any project debris by removal, burning, or placement above high-water flows.*

Section 1-07.5(3) – *State Department of Ecology*: *In doing the work, the contractor shall … dispose of, in ways that will prevent their entry into state waters, all … debris, overburden, and other waste materials.*

Section 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 … remove any excavation material that may have been deposited in or near the stream so that the stream bed is free from obstruction.*

17. Section 6-02.3(25)N – *Prestressed Concrete Girder Erection,* and Section 6-03.3(7)A – *Erection Methods: The contractor shall submit a plan that shows location of barges.*

intent of this MM. Therefore this MM should be incorporated into the special provisions.

MM 21. Construction barges will not be anchored in or above eelgrass or kelp beds, and drill rigs will not operate in or above eelgrass or kelp beds.

The intent of this MM is to prevent damage to eelgrass and kelp beds as a result of shading or disturbance by anchors or drilling equipment.

Because the intent of this MM is not covered by the standard specifications, this measure should be incorporated into the special provisions. All known locations of eelgrass and kelp beds should be delineated on the drawings with a reference note incorporating this MM.

6.4 Developing Appropriate Impact Minimization Measures for Sensitive Species and Habitats

The listed species and habitats present in the vicinity of a project also determine the specific impact minimization measures to be implemented. Frequently, habitat- or species-specific conditions (e.g., restrictions on distance of construction from streams, stream crossing measures, timing restrictions, or noise shields) must be established to support the effect determination for the habitat or species.

The following sections provide explanations of MMs and BMPs developed for sensitive species and also for sensitive habitats. In addition, an example of timing restrictions is provided in a BA writing sample. Compiled lists of common MMs and BMPs illustrate impact minimization measures for selected sensitive habitats.

6.4.1 Impact Minimization Measures for Sensitive Species

If a sensitive species is present or could occur within the project action area, a project biologist may define measures and practices to avoid or minimize project impacts. Two of the most common measures defined to protect sensitive species and ensure given effect determinations are 1) timing restrictions, or 2) excluding or removing the species of concern from the area where impacts are anticipated.

Consider the following project example: Suitable marbled murrelet nesting habitat surrounds a paving project that has an action area confined to the developed portion of a roadway and the area within 60 meters of the roadway to account for noise related impacts. The project is scheduled for construction during the breeding season (April 1 through September 15). It is likely that this project would adversely affect marbled murrelet due to noise and visual impacts. However, if the timing of the project is altered, such that project activities will take place between September 15 and March 31 (outside the breeding season), the potential impacts could be avoided, because murrelets would not utilize the stand outside the breeding season. In that case the project could receive a determination of *no effect* (NE). Similarly, BMPs related to specific equipment or techniques might be required in order to minimize the construction-related noise associated with the project.

Where more than one listed species may be present, timing restrictions must be developed to accommodate the sensitive periods for all potentially affected species. Project biologists should always consult calendars showing sensitive periods for particular species to determine appropriate project timing. Note that timing restrictions must be approved by the project office. If timing restrictions proposed by the project biologist are not feasible, formal consultation may be necessary.

Timing of construction in or near water bodies is dictated by the in-water work windows required in an HPA permit or by the area habitat biologist. NOAA Fisheries or USFWS may have different in-water work windows defined for different species and water bodies. Therefore, it is important to consult with WDFW and the Services to ensure that the proper in-water work window is cited. Calendars of sensitive periods for listed species are provided in PART 3, WILDLIFE SENSITIVE PERIODS CALENDAR.

If an incidental *take* permit is issued by the Services for a project, reasonable and prudent measures (RPMs) likely are stipulated by the Services. These specific measures must be incorporated into the contract to ensure that the project complies with the RPMs, and that impacts to the listed or proposed species are minimized to the greatest extent possible.

6.4.1.1 Exclusion or Removal of Species of Concern from Project Area

Exclusion or removal of listed wildlife species from the vicinity of a project should always be conducted by a trained wildlife or fisheries biologist to ensure that the risk of injury to wildlife is minimized. Because handling listed wildlife or affecting its behavior by preventing access to its customary habitat could constitute a *take* under the Endangered Species Act, often the preferred option for reducing impacts on the species is to establish timing restrictions on construction.

The following example of a MM developed for projects requiring fish exclusion for in-water work illustrates how to word MMs or BMPs appropriately.

MM 22. All fish will be removed from the work area prior to any in-water work activities. Salmonid removal methods, listed in preferential order, are as follows: establishing a net enclosure around the work area, dispersal of salmonids through snorkeling, use of seine nets, dewatering of salmonid habitat, or netting of individuals. Electrofishing will be used as the last resort to remove any remaining fish.

The intent of this MM is to avoid stranding and potential mortality of fish within construction sites.

Although Section 1-07.5(2) of the standard specifications states that any stranded fish are to be released, it includes no requirements for specific fish removal methods. This MM should be incorporated into construction plans and special provisions.

6.4.2 Impact Minimization Measures for Habitats Associated with Sensitive Species

If a sensitive habitat type (e.g., designated critical habitat, suitable habitat, or aquatic resource) could potentially sustain impacts, a project biologist may need to define MMs and BMPs to minimize impacts on those habitat characteristics upon which listed species depend. The following section provides examples of MMs and BMPs that could be used to minimize impacts of proposed activities on sensitive aquatic and terrestrial habitats.

Properly worded MMs and BMPs use committing or obligatory language to emphasize that they are required conditions to be implemented during project construction.

6.4.2.1 Examples of MMs and BMPs: Sensitive Aquatic Habitat

Some common MMs and BMPs for transportation-related projects occurring near sensitive aquatic resources are provided below:

MM 23. Construction impacts will be confined to the minimum area necessary to complete the project.

The intent of this MM is to minimize impacts on the natural environment, including sensitive areas.

The standard specifications do not address this MM in the general manner stated above. This MM should be incorporated into construction plans and special provisions by clearly showing areas where no impacts are allowed (see MM 3).

MM 24. A spill prevention, control, and containment (SPCC) plan will be developed for the project to ensure that all pollutants and products are controlled and contained.

The intent of this MM is to prevent pollutants from entering natural water bodies.

The standard specifications require that an SPCC plan be developed,[18] *approved, and implemented throughout the duration of the project. The*

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18. Section 1-07.15(1) of the standard specifications – *Spill Prevention and Countermeasures Plan*: *The contractor shall prepare a project specific spill prevention, control, and countermeasures (SPCC) plan to be used for the duration of the project. The plan shall identify staging, storage, maintenance, and refueling areas and their relationship to drainage pathways, waterways, and other sensitive areas. The plan shall identify spill prevention and containment methods to be used at each of these locations.*

SPCC plan can be developed by the engineer for the contractor to adopt during construction, although normally the contractor is responsible for developing and implementing the plan.

MM 25. No contractor staging areas will be allowed within 91 meters (300 feet) of any jurisdictional wetland, stream, river, or drainage as identified by the project biologist, unless site-specific review by the project biologist indicates that no impacts on sensitive resource areas will occur due to topography or other factors.

The intent of this MM is to prevent materials from leaving the staging area and entering sensitive areas. For example, erosion of soil piles in staging areas could cause sediment-laden runoff to drain into sensitive areas. The distance specified may be project-specific.

This MM is not addressed in the standard specifications and should be incorporated into construction plans and special provisions.

MM 26. A temporary erosion and sedimentation control (TESC) plan and a source control plan will be developed and implemented for all projects requiring clearing, vegetation removal, grading, ditching, filling, embankment compaction, or excavation. The BMPs in these plans will be used to control sediments from all vegetation-disturbing or ground-disturbing activities.

The intent of this MM is to prevent or minimize drainage of sediment-laden water into sensitive areas.

The standard specifications have provisions for a TESC plan but do not make it mandatory.[19] *The designer has two options to ensure that a TESC plan is developed and implemented for the project: 1) the designer may develop a TESC plan in the special provisions and drawings, in which case the contractor is required by the standard specifications to either adopt or prepare an appropriate TESC plan, or 2) the designer may replace the first sentence in 8-01.3(1)A "Submittals" with the following: "The contractor shall prepare and submit a TESC plan for the engineer's approval."*

19. Section 8-01.3(1)A of the standard specifications – *Submittals – Erosion Control and Water Pollution Control: When a TESC plan is included in the project plans, the contractor shall either adopt or modify the existing TESC plan. The contractor shall obtain the engineer's approval on the TESC plan and schedule before any work begins.*

Section 1-07.15 – *Temporary Water Pollution/Erosion Control: The contractor shall perform all temporary water pollution and erosion control 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. In an effort to prevent, control, and stop water pollution and erosion within the project, thereby protecting the work, nearby land, streams, and other bodies of water, the contractor shall perform all work in strict accordance with all federal, state, and local laws and regulations governing waters of the state, as well as permits acquired for the project.*

MM 27. For projects involving concrete pouring, concrete truck chute cleanout areas will be established to properly contain wet concrete and washwater.

The intent of this MM is to ensure that concrete construction activities occur in designated areas away from sensitive areas.[20]

Designated areas for concrete construction activities should be included in the SPCC plan.

MM 28. Pressure-washing of concrete structures will be held to the minimum necessary to maintain structural integrity. Pressure-washing of concrete structures can result in an increased pH discharge with a potential to violate state water quality criteria.

The intent of this MM is to minimize concrete entering natural water bodies and having adverse effects on fish when preparing previously placed concrete surfaces to obtain proper bond to new concrete.

In addition to the standard specifications, the engineer should include specific requirements to contain, collect, and dispose of concrete washwater in the construction plans and special provisions (also see MM 27).

MM 29. The contractor will protect all inlets and catchments from fresh concrete, tackifier, paving, and paint stripping in case inclement weather unexpectedly occurs.

The intent of this MM is to prevent contaminated construction materials from entering inlets and catchments and being conveyed to natural water bodies or other sensitive areas.

The standard specifications cover this in general. However, it should be required on the TESC or SPCC plans.

MM 30. All exposed soils will be stabilized during the first available period and will not be allowed to sit idle for more than 7 days without receiving the erosion control treatment specified in the TESC plan. In the Puget Sound region, no soils will remain unstabilized for more than 2 days from October 1 to April 30 and for no more than 7 days from May 1 to September 30. Revegetation of construction easements and other areas will occur after the project is completed. All disturbed riparian vegetation will be replanted. Trees will be planted where consistent with highway safety standards. Riparian vegetation will be replanted with species native to that geographic region.

20. Section 1-07.5(3) – *State Department of Ecology*: *The contractor shall dispose of all toxicants, including creosote, oil, cement, concrete, and equipment washwater, in ways that will prevent their entry into state waters.*

The intent of this MM is to minimize erosion of exposed soils and transport of sediment-laden water to sensitive areas.

The standard specifications cover this requirement with regard to the length of time allowed for exposed soils before stabilization is required.[21] *See MM 5 for information regarding replanting with native species.*

MM 31. For all projects located within a listed fish evolutionarily significant unit (ESU) or DPS that involve 0.4 hectares or more (1 acre or more) of clearing, grading, or grubbing, a stormwater site plan will be developed and implemented. The stormwater site plan will include a spill prevention, control, and containment (SCC) plan, a temporary erosion and sedimentation control (TESC) plan, a hydraulic report, a BMP selection form, a water quality discipline report, and a BMP maintenance schedule.

The intent of this MM is to take extra precautions on large projects to prevent sediment-laden water and contaminants from entering natural water bodies and sensitive areas.

The standard specifications include measures for preparation of an SPCC plan (see MM 24) and TESC plan (see MMs 26 and 30). The standard specifications do not address a stormwater site plan, which should be developed by the engineer during the design phase and incorporated into the construction plans and special provisions.

MM 32. Projects will be designed in accordance with the WSDOT *Highway Runoff Manual* (HRM), or the local agency stormwater manual (if required by the local agency having jurisdiction) provided it is more stringent than the *Highway Runoff Manual*.

The intent of this MM is to ensure that stormwater-related impacts on natural water bodies and other sensitive areas are avoided and minimized by following WSDOT stormwater measures.

This MM is not addressed in the standard specifications and should be addressed during the design phase of the project, with necessary measures incorporated into the plans and special provisions.

MM 33. When practicable, all fueling and maintenance of equipment will occur more than 91 meters (300 feet) from the nearest wetland, ditch, or flowing or standing water. (Fueling large cranes, pile drivers, and drill rigs over 300 feet away may not be practicable.)

21. Section 8-01.3(1) of the standard specifications – *General – Erosion Control and Water Pollution Control*: *In western Washington, erodible soil not being worked, whether at final grade or not, shall be covered within the following time period, using an approved soil covering practice, unless authorized otherwise by the engineer: from October 1 through April 30, 2 days maximum; and from May 1 to September 30, 7 days maximum.*

The intent of this MM is to prevent fuel and maintenance equipment spills from entering sensitive areas.

This MM is not specifically addressed in the standard specifications and should be incorporated into the SPCC plan, construction plans, and special provisions.

MM 34. Construction equipment will not enter any water body without authorization from WDFW, NOAA, or USFWS, as appropriate. Equipment will be operated as far from the water's edge as possible.

The intent of this MM is to minimize impacts (e.g., sedimentation) in natural water bodies by doing as much work as possible from beyond the water's edge.

See comments under MMs 13 and 14.

MM 35. Temporary material holding piles will not be placed in the 100-year floodplain during the rainy season (October through May) unless the following conditions are met: 1) storage does not occur when flooding is imminent, and 2) storage piles consisting of erosive material are covered with plastic tarps (or similar) and surrounded with straw bales. (Material used within 12 hours of deposition is not considered a temporary material storage pile.)

The intent of this MM is to prevent temporary material stock piles from being flooded by streams or rivers and washed into natural water bodies.

The standard specifications do not specify the locations where material stockpiles can be placed.

If possible, the designer should identify the 100-year floodplain in relation to the project site.

If the required quantity of plastic covering is significant, the special provisions should include it as a bid item.

MM 36. BMPs will be used for all projects within 61 meters (200 feet) of surface water or wetland habitat as identified by the project biologist, to ensure that no foreign material (such as pavement slurry from asphalt grinding equipment) is sidecast, and to control and prevent sediments from entering aquatic systems.

The intent of this MM (similar to MMs 25 and 33) is to prevent construction waste materials from entering sensitive areas.

BMPs chosen by the engineer during the design phase should be incorporated into the TESC plan and special provisions, in accordance *with Section 8-01.3(1)A of the standard specifications. Additionally, all sensitive areas to be protected must be clearly identified on the contract drawings.*

MM 37. BMPs will be implemented to ensure that no foreign material such as oil or fuel from construction equipment enters marine waters and that sedimentation is minimized.

The intent of this MM is to prevent spills from construction equipment or sediments from entering marine waters.

While prevention of water pollution is a requirement in the standard specifications, this MM is not specifically addressed. BMPs chosen by the designer during the design phase should be incorporated into the SPCC plan, TESC plan, and special provisions, in accordance with Section 1-07.15(1) of the standard specifications.

MM 38. All project-caused unstable slopes with a high likelihood of delivery to listed fish-bearing waters will be stabilized as soon as practicable.

The intent of this MM is to prevent the risk of unstable slopes sliding into natural water bodies.

This MM is not addressed in the standard specifications in the general manner stated above. This MM should be incorporated into the TESC plan and special provisions, in accordance with Section 8-01.3(1)A of the standard specifications. For the specifications to be useful, the designer should pay special attention to the definition of "project-caused unstable slopes."

MM 39. Large woody debris associated with project activities will be left in the riparian area if possible, or retained for future restoration use by WSDOT, or donated to a local watershed group if a need exists.

The intent of this MM is to take advantage of the habitat value of large woody debris by using it to restore riparian areas at the project site or in other restoration projects.

The standard specifications present general requirements for disposal of debris and materials generated during clearing and grubbing activities but do not require special handling or use of large woody debris. Designers should incorporate appropriate requirements into the special provisions to support this MM.

MM 40. No paving, chip sealing, or stripe painting will be initiated in rainy weather.

The intent of this MM is to prevent paving and painting materials from running off the construction site in stormwater and entering sensitive areas.

The standard specifications provide criteria to determine whether site conditions are adequate to ensure quality installation of paving and striping.[22] *However, depending on the sensitive nature of the site, the designer may wish to include stronger weather protection requirements in the special provisions for paving and striping projects.*

Bridge Activities

MM 41. New stream crossing structures will not reduce the existing stream width.

The intent of this MM is to avoid loss of existing habitat area within streams where crossings are proposed.

This MM is not addressed in the standard specifications. Maintaining existing stream width should be addressed during the design phase and shown in the construction plans.

MM 42. Bridge construction will be conducted from the banks or temporary work bridges. Equipment will be kept out of rivers and streams as much as possible.

The intent of this MM is similar to MM 34.

MM 43. Bridge piers and abutments will be built outside the ordinary high water mark (OHWM).

The intent of this MM is to minimize artificial structures within fish habitat.

This MM is not addressed in the standard specifications. The engineer should address this MM during the design phase and designate the locations of bridge piers and abutments on the construction plans.

MM 44. No treated wood debris will be allowed to fall into the water. Any debris that falls in will be removed immediately.

The intent of this MM is to prevent treated wood debris from entering natural water bodies and contaminating them.

22. Section 5-04.3(16) of the standard specifications – *Weather Limitations – Hot Mix Asphalt (HMA)*: *Hot mix asphalt shall not be placed on any wet surface*.

Section 5-02.3(10) – *Unfavorable Weather – Bituminous Surface Treatment*: *Asphalt shall not be applied to wet material*.

This MM is not specifically addressed in the standard specifications. Handling of treated wood should be incorporated into the special provisions. Depending on the site, it may be prudent to require drip tarps that contain and prevent the release of construction-generated debris to waters of the state.

MM 45. All treated wood will be disposed of at a disposal facility approved for treated wood.

The standard specifications require that debris and construction wastes be disposed of in accordance with all local, state, and federal laws. The designer should consider including a note or special provision to reference the standards.

MM 46. During bridge removal projects, as much of the existing structure as possible will be removed before finally dismantling the structure, to limit the amount of material and debris entering receiving waters. This includes all roadbed material, decking, concrete curbs, etc.

The intent of this MM is to prevent treated wood debris from entering natural water bodies and contaminating them.

This is not addressed in the standard specifications and should be incorporated into the special provisions and contract drawings by the designer (also see MM 44).

MM 47. Concentrated accumulations of bird feces, road grit, and sand will be removed from bridges by mechanical sweeping or by hand insofar as practicable before dismantling.

The intent of this MM is to prevent debris from entering and contaminating natural water bodies.

This MM is not specifically addressed in the standard specifications. Removal, containment, and handling of these items should be incorporated into the special provisions.

MM 48. All bridge removal projects will comply with water quality standards identified in the *WSDOT–Washington State Department of Ecology Water Quality Implementing Agreement* or approved temporary water quality modification permit in order to control turbidity levels within approved standards and prevent degradation of water quality.

The intent of this MM is to avoid water quality violations in natural water bodies.

This MM is generally addressed in the standard specifications by the requirement to comply with all local, state, and federal regulations and *any permit requirements. However, the designer should address this MM during the design phase and incorporate appropriate BMPs into the construction plans and special provisions.*

MM 49. Debris accumulations on the bridge, road surface, and within bridge drains will be collected or swept up and properly disposed of prior to flushing with fresh water. Flushing will involve the use of clean water only, to prevent detergents or other cleaning agents from entering waters of the state.

The intent of this MM is to prevent debris on bridges from entering and contaminating natural water bodies.

The standard specifications provide general requirements for control and containment of debris, along with specific measures to be implemented if debris is generated during preparation for painting.[23]

MM 50. Structural cleaning: Bridge structures will be pressure-washed using appropriate filter fabric to control and contain paint particles generated by the activity. Concentrated accumulations of bird feces and nests will not be allowed to drop into the water. This material will be scraped from the bridge structure and collected and disposed of at an appropriate upland location.

The intent of this MM is similar to MM 44.

The standard specifications generally provide for requirements in keeping with this MM.[24] *The designer may find it useful, however, to augment the specification language and include it in the special provisions as well.*

MM 51. Abrasive blasting containment: During abrasive blasting on a steel bridge prior to painting, a containment system appropriate for the type and location of the bridge will be in place and maintained to prevent spent blast media from reaching state waters. Spent blast media will be collected, sampled, classified for its hazardous material content, and disposed of as appropriate for its waste designation.

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23. Section 6-07.3(2)A of the standard specifications – *Bridge Cleaning*: *Following fungicide treatment and removal of bird guano, all steel surfaces to be painted shall be cleaned by either pressure flushing or sweep blasting. When pressure flushing is used, it shall be done with clean, fresh water only. No detergents, bleach, or other cleaning agents shall be employed.*

24. Section 6-07.3(2)A – *Bridge Cleaning*: *All washwater and debris from pressure flushing shall be filtered through a filter fabric capable of collecting all loose debris and particles.*

Section 6-07.3(2)A – *Bridge Cleaning: Bird guano shall be completely removed prior to any other cleaning. 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 intent of this MM is similar to MM 49.

The standard specifications generally provide for requirements in keeping with this MM.[25] *The designer may find it useful, however, to augment the specification language and include it in the special provisions as well.*

Painting Activities

MM 52. Painters shall work from pails containing a maximum of 2 gallons of paint to minimize the impact of accidental spillage, except for sealed containers that are part of a spray system.

The intent of this MM is to minimize the amount of accidental paint spills potentially entering natural water bodies and other sensitive areas.

This MM is covered by the standard specifications for painting steel surfaces.[26] *The designer should confirm that the requirements apply to the site and should augment the special provisions as necessary.*

MM 53. Paint materials and maintenance equipment will not be cleaned in waters of the state, nor will resultant cleaning runoff be allowed to enter state waters.

The intent of this MM is to prevent paint materials from entering natural water bodies or other sensitive areas.

This MM is covered by the standard specifications for painting steel surfaces.[27] *The designer should confirm that the requirements apply to the site and should augment the special provisions as necessary.*

MM 54. Drip pans or other protective devices will be required for all paint mixing and solvent transfer operations.

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25. Section 6.07.3(2)B – *Containment of Abrasive Blasting*: *At the preconstruction conference, the contractor shall submit a written containment system plan, including drawings and describing the methods for waste containment, collection, and disposal, to the engineer for approval. 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 on the waterway and ground surface below.*

Section 6-07.3(2)C of the standard specifications – *Testing and Disposal of Containment Waste: The contractor shall have spent blast media collected, sampled, designated for its hazardous material content, and disposed of as appropriate for its waste designation.*

26. Section 6-07.3(2)G – *Painting Steel Surfaces*: *Painters using brushes shall work from pails containing a maximum of 2 gallons of paint in order to minimize the impact of any spill.*

27. Section 6-07.3(2)G – *Painting Steel Surfaces*: *Cleaning of equipment shall not be done in state waters, nor shall resultant cleaning runoff be allowed to enter state waters.*

The intent of this MM is similar to MM 53.

The standard specifications provide for containment beneath painting activities, but the designer should add language in the special provisions specifying requirements for paint mixing and solvent transfer operations to be conducted in designated areas that are fully protected by spill containment controls.

MM 55. Drip tarps will be suspended below paint platforms to prevent spilled paint, buckets, and brushes from entering state waters.

Subsurface Sampling Activities

MM 56. During subsurface sampling, when working off a highway, bridge deck, barge, or road surface within 100 feet of waters containing listed fish species, a silt fence will be installed between the drilling site and the water body to contain sediments.

The intent of this MM is to prevent sediment-laden water created by subsurface sampling from reaching natural water bodies.

This MM is not addressed in the standard specifications. Subsurface sampling is typically a preconstruction activity. This MM should be communicated to the geotechnical engineer.

MM 57. During subsurface sampling within 100 feet of waters containing listed fish species, where practical, all materials removed from the test hole will be removed from the site.

The intent of this MM is to prevent foreign material from entering natural water bodies.

MM 58. During subsurface sampling within 100 feet of waters containing listed fish species, oil-absorbent pads will be placed under the drill rig to catch and control spills.

The intent of this MM is to prevent drill rig oil spills from entering natural water bodies.

MM 59. For subsurface sampling within 100 feet of waters containing listed fish species, the team lead will have a minimum of 4 hours training on erosion control, spill control, and containment.

The intent of this MM is to prevent spills and sediments from entering natural water bodies.

MM 60. For subsurface sampling within 100 feet of waters containing listed fish species, all existing large woody debris will be left onsite.

The intent of this MM is to prevent loss of habitat by keeping large woody debris onsite.

Stream Bank Activities

MM 61. When feasible, on stream bank protection and slide repair projects, fish habitat improvement measures will be evaluated and implemented by incorporating available large woody debris (LWD) and boulders in the bank protection or repair design.

The intent of this MM is to take advantage of existing large woody debris and boulders that can be incorporated into the design.

This MM is not addressed in the standard specifications. The special provisions should specify that existing large woody debris and boulder material may be used if approved for use by the engineer.

MM 62. Projects that include bank stabilization will follow the *Integrated Stream Bank Protection Guidelines* insofar as practicable.

The intent of this MM is to ensure that bank stabilization projects are appropriately designed and will achieve their objectives.

This MM is not addressed in the standard specifications. The engineer should design bank stabilization projects in accordance with appropriate guidelines and incorporate necessary measures into the construction plans and special provisions.

Temporary Access Roads

MM 63. The development and use of temporary access roads will meet the following conditions:

a) Existing roadways or travel paths will be used whenever reasonable.

b) Where stream crossing are essential, the crossing design will accommodate reasonably foreseeable risks (such as flooding and associated bedload and debris) to prevent diversion of streamflow out of the channel and down the road in the event of a crossing failure.

c) Vehicles and machinery must cross riparian areas and streams perpendicular to the main channel whenever reasonable.

d) Preparation of temporary roads within 150 feet of streams will avoid or minimize soil disturbance and compaction by clearing vegetation to ground level, then either placing clean gravel over geotextile fabric, or using hog fuel (i.e., hog chips) as the temporary road surface. All affected areas will be scarified and replanted, as appropriate, following removal of the temporary road.

e) The number of stream crossings will be minimized.

The intent of this MM is to minimize impacts associated with access roads through sensitive areas, including streams and riparian areas.

This MM is not addressed in the standard specifications. The engineer should consider this MM during the design phase and designate the location of access roads on construction plans. Information pertaining to proper materials and methods of building the access roads should be stated in the special provisions.

6.4.2.2 Examples of MMs and BMPs: Sensitive Terrestrial Habitat

Examples of MMs and BMPs identified for projects located near sensitive prairie habitat, sand dunes, salt-spray meadows, open-field habitat, nesting sites, or marbled murrelet habitat include but are not limited to the following:

MM 64. A temporary erosion and sedimentation control (TESC) plan and a source control plan will be developed and implemented for all projects requiring clearing, vegetation removal, grading, ditching, filling, embankment compaction, or excavation. The BMPs in these plans will be used to control sediments from all vegetation-disturbing and ground-disturbing activities.

MM 65. No contractor staging areas will be allowed within 61 meters (200 feet) of potential prairie habitat, as identified by the project biologist, unless site-specific review completed by the project biologist indicates that no impacts to the sensitive resource areas will occur due to topography or other factors.

MM 66. BMPs will be implemented for all projects within 61 meters (200 feet) of prairie habitat to minimize sediment impacts and to ensure that no foreign material (such as pavement slurry from grinding equipment) is sidecast or stored in prairie habitat.

MM 67. BMPs will be implemented for all projects within 61 meters (200 feet) of sand dunes, salt-spray meadows, or open-field habitat (including suitable Oregon silverspot butterfly habitat) to minimize sediment impacts and to ensure that no foreign material (such as pavement slurry from grinding equipment) will be sidecast or stored on dunes or meadows. The distance from sand dunes, salt-spray meadows, or open-field habitat where BMPs will be necessary may be modified by the project biologist after a site-specific review is conducted to ensure that no impact will occur.

MM 68. All trash, food waste, and other items attractive to crows, jays, and other Corvidae will be picked up and removed from the project area on a daily basis for projects within 1.6 kilometers (1 mile) of suitable or critical marbled murrelet nesting habitat.

The intent of this MM is to prevent potential predation of murrelet nestlings by corvids.

This MM is not addressed in the standard specifications and should be incorporated into the special provisions.

MM 69. Construction of new facilities such as rest area maintenance facilities within 5 miles of suitable or critical marbled murrelet nesting habitat will implement a trash handling plan to ensure that food wastes and other items attractive to crows, jays, and other Corvidae will be removed and unavailable to wildlife.

The intent of this MM is to prevent potential predation of murrelet nestlings by corvids.

This MM is not addressed in the standard specifications but should be implemented after construction.

MM 70. Trees that are removed in suitable spotted owl or murrelet habitat are to be dropped into the road right-of-way or in other areas that will be cleared. Where large woody debris is lacking in adjacent forests, felled trees are to be placed in the forest, where practicable and agreeable to the adjacent property owner, following coordination with and approval by USFWS.

When it is absolutely necessary to remove trees in suitable spotted owl or murrelet habitat, the intent of this MM is to reintroduce the trees as large woody debris (LWD) habitat on the forest floor. This way, the trees can be put to a good use and provide habitat for small mammals and other wildlife. In addition, the felled trees can function as nurse logs for other vegetation such as red huckleberry and western hemlock trees.

This MM is not addressed in the standard specifications. The designer should specify the locations for placement of large woody debris on the construction plans or provide measures in the special provisions for a biologist to approve locations during construction.

MM 71. Projects involving bridge replacement within the range of the grizzly bear will design the new structure to accommodate wildlife crossings, when practicable.

The intent of this MM is incorporate measures that support the recovery of grizzly bears.

This MM is not addressed in the standard specifications and should be incorporated into the construction plans and special provisions.

MM 72. No contractor staging areas will be allowed within 200 feet of northern wormwood habitat as identified by the project biologist.

7.0 Construction Noise Impact Assessment

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7.0 Construction Noise Impact Assessment

Chapter Summary

- The project biologist must analyze the extent of noise because it is one element used to define the action area.
- The project biologist must analyze the effects of noise on all animal species addressed in the BA.
- The two most common types of in-air noise based on attenuation dynamics are point source and line source.
- Natural factors such as topography, vegetation, and temperature can reduce in-air noise over distance. A hard site exists where noise travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. When ground cover or normal unpacked earth is present between the source and receptor, the ground becomes absorptive to noise energy and is called a soft site.
- Topography, vegetation, and atmospheric factors can also affect the rate of noise attenuation.
- Existing sound levels can serve as a baseline from which to measure potential disturbance caused by project activities. Baseline sound is characterized as either background or ambient sound and levels vary greatly and depend on site-specific factors.
- Most transportation projects have traffic noise as part of the site background sound levels. Identifying the amount and type of traffic helps to determine the background sound level.
- One of the hardest things to quantify is noise associated with construction activities.
- Although noise from multiple sources at the same location results in louder levels than a single source alone, decibels are measured on a logarithmic scale, so noise levels cannot be added by standard addition.
- Defining the extent of project-related noise requires the following steps:

    1. Estimate the equipment noise level for the project.

    2. Estimate the background sound level. In most cases this can be done by defining traffic noise levels in the project area. In situations where background sound levels include intermittent

peaks, try to identify the general background condition. For example, at a ferry terminal, the ferry whistle is usually the loudest background sound source. If the ferry whistle is infrequent, it would be more meaningful for the analysis to use the background condition without these peaks to compare to project-related noise. However, in cases where frequent port horns and whistles occur that consistently cause an increase to the background sound level (L_{eq} (h)) then it would be inappropriate to exclude them.

3. Determine whether hard or soft site conditions exist.

4. Determine whether the construction noise is a point source or line source noise.

- Use the correct equation to solve for the distance construction noise will travel before it attenuates to the ambient or background sound level. In some instances (for example projects that are politically volatile or subjected to significant public scrutiny or those that occur in areas of extreme or highly variable topography), a project may require a more rigorous noise assessment for determining the extent of the action area.

- The Services provide threshold values for making effect determinations for some listed species. The threshold distances for in-air noise are defined as a known distance where noise at a given level elicits some response from a target species.

- The in-air noise assessment for northern spotted owls and marbled murrelets should estimate noise-only detectability thresholds, noise-only alert and disturbance thresholds, and noise-only harassment/injury thresholds. Use the correct equation to determine construction noise levels at a specific distance.

- Over long distances, water currents bend underwater noise waves upward when propagated into the current and downward downstream. Noise waves bend toward colder, denser water.

- Underwater noise levels are measured with a hydrophone, or underwater microphone, which converts sound pressure to voltage, expressed in Pascals (Pa), pounds per square inch (psi), or decibels (dB).

- Transmission loss (TL) underwater is the accumulated decrease in acoustic intensity as an acoustic pressure wave propagates outward from a source. The intensity of the noise is reduced with increasing distance due to spreading.

- Noise propagation factors in water include hydrographic conditions that affect noise transmission, such as currents or tides, sediment types, bottom topography, structures in the water, slope of the bottom, temperature gradient, and wave height.

- Existing underwater sound levels serve as a baseline from which to measure potential disturbance associated with project activities.
- When analyzing the extent of project-related noise, consider the area underwater through which the noise travels until it reaches ambient or background levels or encounters a land mass.
- The steps for defining the extent of project-related underwater noise are as follows:
  1. Determine the noise level for the project.
  2. Determine the background sound level.
  3. Determine applicable noise reduction factors.
  4. To determine the decrease in intensity of the noise away from the source, calculate noise attenuation at 4.5 dB per doubling of distance (Practical Spreading Model).
  5. Calculate the potential distance at which the project noise will attenuate to background levels, or encounter a land mass.
- For aquatic species, risk of injury or mortality resulting from noise is generally related to the effects of rapid pressure changes, especially on gas-filled spaces in the animal's body (such as swimbladder, lungs, sinus cavities, etc.).
- Generally, in-water or near-water pile driving is the issue of concern for the Services on WSDOT projects. If underwater blasting (not usually an issue for transportation projects) will occur this should also be analyzed.
- Different aquatic species exhibit different hearing ranges, so the analysis should consider whether the frequency range of the activity overlaps with that of the species. Threshold distances and noise levels have been established to be used as a basis for effect determinations for salmon, bull trout, marbled murrelet, Steller sea lion, and killer whale.
- NMFS has issued a calculator to aid in the analysis of underwater sound effects on fishes that is available on-line at: <http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#Noise>.

- USFWS has issued a calculator to aid in the analysis of underwater sound effects on diving marbled murrelets that is available on-line at the WSDOT website listed immediately above.

Noise from project activities can adversely affect wildlife in various ways. This chapter provides guidance on identifying construction-related noise and noise impacts in both terrestrial and aquatic settings. Basic acoustic concepts are covered, including noise generation, transmission, and reduction. Identifying ambient or background sound levels for comparison with anticipated project-related noise can assist the project biologist in more accurately identifying the extent of project-related noise and potential impacts on listed species.

The terms noise and sound should not be used interchangeably. *Noise* is characterized as unwanted sound, and because *ambient* and *background* sound are not considered adverse, they are not classified as noise. The ambient sound level is the total of all sound sources excluding anthropogenic sources. The background sound level is a composite of sound from all sources including anthropogenic sources. Ambient or background sound levels are the starting point for analyzing construction noise impacts such that the analysis measures and compares project-related noise to either ambient or background sound based on which best applies to existing site conditions.

Three other terms used in this chapter are *source*, *path*, and *receiver*. The source is where a sound comes from, the path is the intervening terrain and factors that help to reduce the noise, and the receiver is the targeted recipient of the noise (e.g., human, eagle, microphone, etc.).

This discussion focuses on identifying the extent of project-related noise, which represents one element of the project action area, and the potential for noise impacts on wildlife. Noise transmission through air and noise impacts on terrestrial species are addressed first. Next, underwater noise, sound pressure levels, and their effects on fish, diving marine birds, and marine mammals are discussed.

7.1 Terrestrial Noise

Noise is transmitted through air when an object moves, like water flowing over rocks, or air passing through vocal cords. This movement causes air waves, similar to ripples in water. When these waves reach an animal's ears, they are perceived as sound. Sound is usually measured in decibels (dB). A decibel is a relative measure, not an absolute measure, that is accompanied by a reference scale (dB = 20 * log (P1/Pr), where P1 is the measured noise pressure and Pr is the reference pressure) to denote the Sound Pressure Level (SPL).

In-air noise when frequency-weighted to approximate human hearing is measured on an A-weighted scale, denoted as dBA.[1] The A-weighted decibel scale begins at zero, which

1 For sound pressure in air, the reference pressure is usually 20 micro-Pascal (μPa). One Pascal is the pressure resulting from a force of 1 newton exerted over an area of 1 square meter. Sound measured in air scale is referenced to 20 μPa in this document.

represents the faintest sound level that humans with normal hearing can hear. Decibels are measured on a logarithmic scale so each 10 dB increase doubles the sound; therefore a noise level of 70 dBA is twice as loud to the listener as a noise of 60 dBA (USDOT 1995). Table 7-1 shows typical noise levels generated by common indoor and outdoor activities, and provides possible human responses.

Table 7-1. Typical noise levels and possible human responses.

Common Noises	Noise Level (dBA)	Effect
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Carrier deck jet operation Air raid siren	140	Painfully loud
Thunderclap	130	Painfully loud
Jet takeoff (200 feet) Auto horn (3 feet)	120	Maximum vocal effort
Pile driver Rock concert	110	Extremely loud
Garbage truck Firecrackers	100	Very loud
Heavy truck (50 feet) City traffic	90	Very annoying Hearing damage (8 hours of exposure)
Alarm clock (2 feet) Hair dryer	80	Annoying
Noisy restaurant Freeway traffic Business office	70	Telephone use difficult
Air conditioning unit Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room Bedroom Quiet office	40	Quiet
Library/soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	Very quiet
	10	Just audible
Threshold of hearing	0	Hearing begins

From: <http://www.nonoise.org/resource/educat/ownpage/soundlev.htm>.

7.1.1 Noise Generation, Transmission, and Reduction

7.1.1.1 Noise Sources

Noise is a pressure wave that decreases in intensity over distance from the source. Noise attenuation is generally described as a reduction in decibel level per doubling of distance from the source. Depending on the nature of the noise source, noise propagates at different rates. When reporting the noise level from a source, one should always specify the reference distance from the source for the sound measurement or estimated source. A standard reference distance for source noise levels is 50 feet. The two most common types of noise are point source and line source. These are discussed in more detail below.

Point Source Noise

Point source noise is usually associated with a source that remains in one place for extended periods of time, such as with most construction activities. A few examples of point sources of noise are pile drivers, jackhammers, rock drills, or excavators working in one location. However, noise from a single traveling vehicle is also considered a point source noise.

Construction point source noise is commonly measured by maximum decibel level (L_{max}), or the highest value of a sound pressure over a stated time interval (Harris 1991). Noise from a point source spreads spherically over distance. Think of this as a 3-dimensional model, where the wave spreading creates a dome effect, traveling in all directions equally from the source. The standard reduction for point source noise is 6 dB per doubling of distance from the source.

Line Source Noise

Line source noise is generated by moving objects along a linear corridor. Highway traffic is a good example of line source noise. When assessing line source noise levels the analyst should measure or estimate over longer time periods such as the L_{eq}(h) rather than in maximum levels such as the L_{max} measured for point source noise. Only when noise comes from a very long continuous noise source such as a very long conveyor belt should the line source be represented by maximum event levels such as (L_{max}).

Noise from a line source spreads cylindrically, spreading outward along the length of a line. The standard reduction for line source noise is 3 dB per doubling of distance from the source (compared to 6 dB for construction point source noise).

Table 7-2 provides an example of noise attenuation of construction point and line source decibel levels based on distance from the source.

7.1.1.2 Noise Path Reduction Factors

Natural factors such as topography, vegetation, and temperature can further reduce noise over distance. This section covers a few of the common factors and their applicability in increasing the noise reduction per doubling of distance from the source.

Hard Site versus Soft Site

A hard site exists where noise travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. These are examples of reflective ground, where the ground does not provide any attenuation. The standard attenuation rate for hard site conditions is

6 dB per doubling of distance for point source noise and 3 dB per doubling of distance from line sources.

Table 7-2. Example of noise reduction over distance from a 95 dBA source showing variation between construction point source and line source.

	Noise Attenuation	
Distance from Source (feet)	Point Source (–6 dB)	Line Source (–3 dB)
50	95 dBA	95 dBA
100	89 dBA	92 dBA
200	83 dBA	89 dBA
400	77 dBA	86 dBA
800	71 dBA	83 dBA
1,600	65 dBA	80 dBA
3,200	59 dBA	77 dBA
6,400	53 dBA	74 dBA

When ground cover or normal unpacked earth (i.e., a soft site) exists between the source and receptor, the ground becomes absorptive of noise energy. Absorptive ground results in an additional 1.5 dB reduction per doubling of distance as it spreads from the source. Added to the standard reduction rate for soft site conditions, point source noise attenuates at a rate of 7.5 dB per doubling of distance, and line source noise decreases at a rate of 4.5 dB per doubling of distance.

Topography, Vegetation, and Atmospheric Factors

A break in the line of sight between the noise source and the receptor can result in a 5 dB reduction. Dense vegetation can reduce noise levels by as much as 5 dB for every 100 feet of vegetation, up to a maximum reduction of 10 dB over 200 feet (USDOT 1995). Atmospheric conditions can also affect the rate of noise attenuation. Noise travels farther during periods of higher humidity and also in colder temperatures (USDI 2003). Wind can reduce noise levels by as much as 20 to 30 dB at long distances (USDOT 1995).

The influences of vegetation, topography, and atmospheric conditions as noise reduction factors can vary greatly so are difficult to include in an analysis. Therefore, these factors are generally not taken into account in environmental noise analyses over short distances. As a result, such analyses are conservative and likely to predict noise levels that are higher than actual noise levels.

7.1.2 Ambient or Background Sound Conditions

As defined for this manual, ambient sound level is the total of all sound sources in a specific area excluding anthropogenic sources. The background sound level is a composite of sound from all sources including anthropogenic sources. Either the ambient or background sound level is selected as the baseline for evaluating construction noise impacts based on existing site conditions.

7.1.2.1 Existing Conditions

Determining background or ambient sound levels the first step for a noise assessment. It can vary greatly depending on site-specific factors. Environmental factors can elevate background sound near the source, effectively hiding, or masking construction noise. The same environmental factors occurring near the receiver can change the receiver's perception of how loud construction noise is, or hide it completely.

Background and ambient sound levels vary by location even for undisturbed forested areas. A WSDOT noise analyses on the San Juan Islands identified an ambient level of about 35 dBA, with regular noise intrusions from traffic and aircraft overflights ranging from 45 to 72 dBA (WSDOT 1994). A study on the Mt. Baker-Snoqualmie National Forest listed forested ambient levels between 52 and 60 dBA (USDA Forest Service 1996). The Olympic National Forest programmatic biological assessment uses an estimated ambient level of 40 dBA for undisturbed forested areas (USDI 2003). The environment surrounding transportation projects is often composed of high-speed highways, busy ferry terminals, and urban development. For projects occurring in these areas, background sound levels will be much higher than that of a forested or undeveloped setting (see Section 7.1.4.1).

Weather conditions such as wind or rainfall can increase ambient sound in undeveloped areas. Locations near rivers or streams have higher ambient sound levels as well. As with the atmospheric conditions described above, environmental factors are so variable that models rarely take them into account.

The WSDOT project biologist should check with the WSDOT project manager to see if ambient or background sound data are available for the project or similar areas. If ambient or background information is not available and noise may be a major concern in the consultation, the biologist should have ambient or background sound within the project area measured by a professional.

7.1.2.2 Traffic Noise

The majority of projects assessed by a project biologist will include background traffic noise. Identifying the amount and type of traffic helps to determine the background sound level. The level of highway traffic noise depends upon the traffic volume, the vehicle speeds, and the mix of trucks in the flow of traffic (USDOT 1995). Generally, the loudness of traffic noise is increased when traffic is heavier, when traffic speed is increased, and when a greater proportion of the traffic flow is heavy trucks.

For traffic volume, 2,000 vehicles per hour sounds twice as loud as (or is 10 dBA higher than) 200 vehicles per hour (USDOT 1995). For traffic speed, traffic at 65 miles per hour (mph) sounds twice as loud as traffic at 30 mph (USDOT 1995). In regard to the proportion of heavy truck traffic, one truck at 55 mph sounds as loud as 28 cars at 55 mph (USDOT 1995).

Vehicle noise comes from a combination of sources produced by engines, exhaust, and tires. The loudness of vehicle noise can also be affected by the condition and type of roadway, road grade, and the condition and type of vehicle tires.

Table 7-3 lists typical traffic noise levels for a variety of traffic volumes at various speeds, assuming 4 percent medium trucks, 6 percent heavy trucks, and a sound level modeled at 50 feet from the source. These numbers would be elevated as the percent of truck traffic volume increases. The State Highway Log can be used to find the posted speed for a state route. The Annual Traffic Report can be used to find the traffic volume, where traffic volume in vehicles per hour is equal to 10 percent of the Average Daily Traffic (ADT).

Table 7-3. Typical noise levels for traffic volumes at a given speed.

Sound Level (dBA L_{eq} (hour)) at 50 feet

Volume (vehicles/hour) \ **Speed (miles/hour)**	35	40	45	50	55	60	65 / T60	65	70 / T60	70	75 / T60	75
125	57.3	58.5	59.7	60.9	62.0	63.1	63.8	64.1	64.5	65.1	65.2	66.1
250	60.2	61.4	62.6	63.8	64.9	66.0	66.7	67.0	67.4	68.0	68.2	69.0
500	63.2	64.4	65.6	66.8	67.9	69.0	69.7	70.0	70.4	71.0	71.2	72.0
1,000	66.2	67.4	68.6	69.8	70.9	72.0	72.7	73.0	73.5	74.0	74.2	75.0
2,000	69.2	70.4	71.6	72.8	73.9	75.0	75.7	76.1	76.5	77.0	77.2	78.0
3,000	71.0	72.2	73.4	74.6	75.7	76.8	77.5	77.8	78.2	78.8	79.0	79.8
4,000	72.2	73.4	74.6	75.8	76.9	78.0	78.7	79.1	79.5	80.1	80.2	81.0
5,000	73.2	74.4	75.6	76.8	77.9	79.0	79.7	80.0	80.4	81.0	81.2	82.0
6,000	74.0	75.2	76.4	77.6	78.7	79.8	80.5	80.8	81.2	81.8	82.0	82.8

T is the speed limit for truck traffic when it is posted differently from other vehicle traffic.

The State Highway Log is available at <http://www.wsdot.wa.gov/mapsdata/roadway/statehighwaylog.htm>; and the Annual Traffic Report is available at <http://www.wsdot.wa.gov/mapsdata/travel/annualtrafficreport.htm>.

7.1.3 Construction Noise

One of the easiest things for the project biologist to identify and one of the hardest things to quantify is noise associated with the actual construction of the project. How much noise will construction generate, how often will it occur, and how long it will last, are all questions that should be answered in the assessment. This section provides an introduction to equipment noise characteristics that the project biologist can use for typical construction projects.

Construction is usually performed in a series of steps or phases, and noise associated with different phases can vary greatly. However, similarities in noise sources allow typical construction equipment to be placed into one of three categories: heavy equipment, stationary equipment, or impact equipment.

7.1.3.1 Heavy Equipment

Analysts can categorize heavy equipment as earth-moving equipment, such as excavating machinery like excavators, backhoes, and front loaders, as well as materials handling equipment like graders, pavers, rollers, and dump trucks. Average maximum noise levels (L_{max}) at 50 feet from heavy equipment range from about 73 to 101 dBA for non-impact equipment (Table 7-4). These numbers were identified from several studies, and represent average maximum noise levels of reported values. During a phase of construction using heavy equipment, noise is generated more or less at a constant level. Therefore, noise levels can be quantified based on an average hourly level.

Lacking onsite noise level data, the project biologist should use the worst-case scenario of the known equipment noise levels for a noise analysis. Manufacturers may also provide noise levels for their equipment, but the biologist must know the specific make and model of the equipment to be used for the project in order to obtain that information. Care should be taken to identify the distance at which the manufacturer has measured the equipment and ensure that the sound levels are provided as L_{eq} or L_{max} and not as a sound power level.

7.1.3.2 Stationary Equipment

Stationary equipment such as pumps, power generators, and air compressors generally run continuously at relatively constant power and speeds. Noise levels at 50 feet from stationary equipment can range from 68 to 88 dBA, with pumps typically in the quieter range. The biologist can also assume an averaged noise level for stationary equipment because of its fixed location and constant noise pattern.

7.1.3.3 Impact Equipment

Impact equipment includes pile drivers, jackhammers, pavement breakers, rock drills, and other pneumatic tools where a tool bit touches the work. The noise from jackhammers, breakers, rock drills, and pneumatic tools comes from the impact of the tool against material. These levels can vary depending on the type and condition of the material. Noise levels at 50 feet from impact equipment, including pile drivers, jackhammers, and rock drills can range from 79 to 110 dBA. Blasting may be associated with impact equipment use and that noise can reach 126 dBA.

An impact pile-driving hammer is a large piston-like device that is usually attached to a crane. The power source for impact hammers may be mechanical (drop hammer), air steam, diesel, or hydraulic.

Most impact pile driver hammers have a vertical support that holds the pile in place, and a heavy weight, or ram, moves up and down, striking an anvil that transmits the blow of the ram to the pile. In hydraulic hammers, the ram is lifted by fluid, and gravity alone acts on the down stroke.

Table 7-4. Average maximum noise levels at 50 feet from common construction equipment.

Equipment Description	Impact Device?	Actual Measured Average L_{max}[b] at 50 feet
Auger Drill Rig	No	84
Backhoe	No	78
Blasting (rock slope production) [a]	Yes	126
Blasting (mitigated rock fracturing) [a]	Yes	98
Boring Jack Power Unit	No	83
Chain Saw	No	84
Clam Shovel (dropping)	Yes	87
Compactor (ground)	No	83
Compressor (air)	No	78
Concrete Mixer Truck	No	79
Concrete Pump Truck	No	81
Concrete Saw	No	90
Crane	No	81
Dozer	No	82
Drill Rig Truck	No	79
Drum Mixer	No	80
Dump Truck	No	76
Excavator	No	81
Flat Bed Truck	No	74
Front End Loader	No	79
Generator	No	81
Generator (<25KVA, VMS signs)	No	73
Gradall	No	83
Grader [a]	No	89
Grapple (on backhoe)	No	87
Horizontal Boring Hydr. Jack	No	82
Impact Pile Driver [a]	Yes	110
Jackhammer	Yes	89
Man Lift	No	75
Mounted Impact Hammer (hoe ram)	Yes	90
Pavement Scarafier	No	90
Paver	No	77
Pickup Truck	No	75
Pneumatic Tools	No	85
Pumps	No	81
Refrigerator Unit	No	73
Rivet Buster/chipping gun	Yes	79
Rock Drill	No	81
Roller	No	80

Table 7-4 (continued). Average maximum noise levels at 50 feet from common construction equipment.

Equipment Description	Impact Device?	Actual Measured Average L_{max}[b] at 50 feet
Sand Blasting (Single Nozzle)	No	96
Scraper	No	84
Shears (on backhoe)	No	96
Slurry Plant	No	78
Slurry Trenching Machine	No	80
Tractor[a]	No	84
Vacuum Excavator (Vac-truck)	No	85
Vacuum Street Sweeper	No	82
Ventilation Fan	No	79
Vibrating Hopper	No	87
Vibratory Concrete Mixer	No	80
Vibratory Pile Driver	No	101
Warning Horn	No	83
Water Jet Deleading	No	92
Welder / Torch	No	74

[a] WSDOT measured data in FHWA's Roadway Construction Noise Mode Database (2005).
[b] L_{max} is the maximum value of a noise level that occurs during a single event.

A diesel hammer, or internal combustion hammer, carries its own power source and can be open-end or closed-end. An open-end diesel hammer falls under the action of gravity alone. A closed-end diesel hammer (double-acting) compresses air on its upward stroke and therefore can operate faster than open-end hammers.

Vibratory pile driver hammers are also used on projects. A vibratory pile-driving hammer has a set of jaws that clamp onto the top of the pile. The pile is held steady while the hammer vibrates the pile to the desired depth. Because vibratory hammers are not impact tools, noise levels are typically not as high as with impact pile drivers. However, piles installed with a vibratory hammer must often be proofed, which involves striking the pile with an impact hammer to determine its load-bearing capacity, possibly with multiple impacts. The project biologist should check with the design engineer to determine if impact driving or proofing of the piles will be needed. If so, the project biologist should include proofing noise from impact pile driving in the assessment.

Although stationary equipment noise and heavy equipment noise can be averaged over a period of time, impact pile driving noise consists of a series of peak events. Generally, noise from impact pile driving is reported at maximum levels. The loudest in-air noise from impact pile driving results from the impact of the hammer dropping on the pile, particularly when hollow steel piles are used. Though noise levels are variable during pile driving, to be conservative (more protective of the listed species), the project biologist should assume that noise at the highest levels documented is generated by impact pile driving and should avoid using an average in a noise assessment.

When conducting an in-air noise assessment involving impact driving of hollow steel piles, USFWS currently recommends assuming a noise level of 115 dBA L_{max} at 50 feet (for 30-inch piles) (Visconty 2000) as a worst-case scenario, where L_{max} is the maximum value of a noise level that occurs during a single event. Most of the documented studies have maximum decibel levels between 95 and 115 dBA, with only one documented level above 115 dBA. Noise assessments by WSDOT have documented maximum levels of 110 dBA (for 24-inch piles) (WSDOT 1994, 1995). If site-specific information is available, or smaller diameter piles are used, it may be appropriate to substitute lower values.

Noise from blasting should be included in the discussion on impact equipment. Since blast noise typically is infrequent and of short duration, blast noise is generally assessed using a different noise metric than what is used for other more continuous types of noise. Blasting can occur in different situations and a variety of methods may be used. Due to the variability in blasting situations and techniques, noise from blasting is not fully addressed in this chapter. However, when blasting noise is part of a project, the project biologist should consider the following factors:

- Substrate – The location where blasting occurs partially determines the size of the charge and the duration of blasting. Blasting through bedrock requires more time and effort than blasting through less dense substrate.

- Size of charge – Blasting can use charges of less than a pound to over 200 pounds.
- Detonation system – Precision blasting may use a sequential delay system where each blast is subdivided into many smaller blasts, separated by a few milliseconds; or the blast may occur all at once.
- Directivity – Blasting above ground acts like point-source noise and spreads spherically from the source. Where blasting occurs below ground level, as in a shaft or pit, some directivity occurs, which directs the force of the blast upward more than horizontally, thereby lessening impacts.
- Use of BMPs – Best management practices may be used to lessen the energy of the blast. For example, when the charge is small enough, the use of heavy mats to cover the charge can significantly reduce the blast energy and contain any flying debris.

7.1.3.4 Rules for Decibel Addition

Now that the project biologist can identify the type and level of construction equipment noise, it is important to discuss what happens when several pieces of equipment are operating at one time. Although noise from multiple sources at the same location results in louder levels than a single source alone, the decibel is measured on a logarithmic scale, so noise levels cannot be added by standard addition. Two noises of equal level (±1 dB) combine to raise the noise level by 3 dB. However, if two noises differ by more than 10 dB, there is no combined increase in the noise level; the higher output covers any other noise. The rules for decibel addition are shown in Table 7-5.

Table 7-5. Rules for combining noise levels.

When two decibel values differ by:	Add the following to the higher decibel value:
0 or 1 dBA	3 dBA
2 or 3 dBA	2 dBA
4 to 9 dBA	1 dBA
10 dBA or more	0 dBA

Source: USDOT (1995).

To determine the combined noise level of all construction equipment operating together, the project biologist should find the three pieces of equipment with the loudest noise levels, add the two lowest levels together using the rules of decibel addition as is shown in Table 7-5, then add the result to the third noise level using the same rules in Table 7-5. For Example: a project's three loudest pieces of equipment have noise levels of 80, 79, and 70 dBA. Add the two lowest pieces of equipment using Table 7-5: 79 – 70 = 9; therefore 1 dBA is added to79 dBA, resulting in a combined noise level of 80 dBA. Add 80 dBA to the next loudest piece of equipment using

Table 7-5: 80 – 80 is a difference of 0 or more; therefore 3 dBA is added to 80 dBA, resulting in a total noise level for all equipment combined of 83 dBA.

7.1.4 Determining the Extent of Project Related Noise

This discussion has introduced basic concepts and provided information on construction-related noise, traffic noise, and baseline sound levels. Using this information, the project biologist should be able to identify the extent of project-related noise, which constitutes one element defining the project action area. This section provides instructions for establishing the extent of noise and defining the noise element of the action area.

7.1.4.1 Determining the Background Sound Level

As part of the noise assessment, it is important to identify the background or ambient sound level throughout the area where construction noise is expected to extend. For transportation projects, traffic noise frequently exceeds the ambient sound level in the project area. However, in highly urbanized areas, other sounds may exceed traffic noise levels. Similarly, for projects in rural areas with little or no traffic, background sound levels also may not be defined by traffic noise.

Background sound levels vary depending on the level of development. Urban areas have the highest background sound levels, with daytime levels approximating 60 to 65 dBA (EPA 1978). Suburban or residential areas have background levels around 45 to 50 dBA (EPA 1978), while rural areas are the quietest with sound levels of 35 to 40 dBA (EPA 1978). In a more recent study, Cavanaugh and Tocci (1998) identify typical urban residential background sound at around 65 dBA, high-density urban areas at 78 dBA, and urban areas adjacent to freeway traffic at 88 dBA. These sound levels may be important in a project noise assessment if traffic is absent near the project site or if construction noise extends beyond the extent of traffic background sound. In this case, the project biologist can use Table 7-6, which lists daytime sound levels, exclusive of traffic, based on population density to determine the background sound level.

Table 7-6. Estimating existing environmental background noise levels.

Population Density (people per square mile)	L_{eq}[a] Daytime Noise Levels Exclusive of Traffic (dBA)
1-100	35
100-300	40
300-1,000	45
1,000-3,000	50
3,000-10,000	55
10,000-30,000	60
30,000 and up	65

Source: FTA (2006).

[a] Where L_{eq} is the *equivalent sound pressure level*: the steady noise level that, over a specified period of time, would produce the same energy equivalence as the fluctuating noise level actually occurring.

In urban and developed areas, traffic noise and construction noise attenuate (decline) to background in less distance than in undeveloped or rural areas. For example, it may take 2 miles or more for construction noise to reach background levels in a rural area, but the same noise may attenuate to urban background levels in less than a mile. For many transportation projects, however, traffic noise determines the background sound level.

A general guideline is:

- If the distance where traffic noise attenuates to ambient or background levels is greater than the distance where construction noise attenuates to ambient or background levels, then the extent of construction noise is equal to the distance where construction noise attenuates to traffic noise levels. In this scenario, traffic noise from the roadway extends farther than construction noise. The extent of project noise is then calculated to where it attenuates to the traffic noise level, which is the dominant background sound. In this case, traffic noise is louder than ambient or background levels, and construction noise is audible until it attenuates to the same level as traffic noise.
- Conversely, if the distance where traffic noise attenuates to ambient or background levels is less than the distance where construction noise attenuates to ambient or background levels, then the extent of construction noise is equal to the distance where construction noise attenuates to ambient or background levels. In this case, construction noise extends farther than traffic noise from the roadway. The extent of project noise is then calculated to where it attenuates to the surrounding ambient or background levels. In this case, construction noise dominates until it attenuates to the same level as surrounding ambient or background sound.

Table 7-7 displays this relationship.

Table 7-7. Extent of project-related noise based on attenuation to the dominant background level.

If the distance noise attenuates:			The distance noise attenuates:			The distance of the extent of construction noise is based on attenuation:	
From	To		From	To		From	To
Traffic	Ambient/Background	>	Construction	Ambient/Background	Then	Construction	Traffic
Traffic	Ambient/Background	<	Construction	Ambient/Background	Then	Construction	Ambient/Background

7.1.4.2 Equations for Solving Distances

Base 10-Log equations are used to calculate noise levels at a specific distance from the source (such as construction noise levels at a nest located 650 feet from a project), to determine the distance construction noise will travel before it attenuates to the traffic noise level, and also to determine the distance at which construction or traffic noise will attenuate to background or ambient sound levels.

To determine construction noise levels at a specific distance, the following equation should be used:

$$\mathbf{L_{max} = Construction\ L_{max}\ at\ 50\ feet - 25 * Log(D/D_o)}$$

Where L_{max} = highest A-weighted sound level occurring during a noise event during the time that noise is being measured.
At 50 feet = the reference measurement distance (standard is 50 feet)
D = the distance from the noise source
D_o = the reference measurement distance (50 feet in this case)

Example *– Project-related noise is estimated at 84 dBA, and traffic noise is estimated at 66 dBA with 40 dBA for ambient sound in a forested site (soft site). A spotted owl nest is located 650 feet from the project. What is the expected construction noise level at the nest site?*

*L_{max} = Construction L_{max} at 50 feet – 25 * Log(D/D_o)*
Where L_{max} = 84 dBA
D = 650
D_o = the reference measurement distance (50 feet in this case)

*L_{max} = 84 dBA at 50 feet – 25 * Log(650/50)*
*L_{max} = 84 dBA at 50 feet – 25 * Log(13)*
L_{max} = 84 dBA at 50 feet – 27.85
L_{max} = 56.15 dBA

To determine the distance point source construction noise will travel before it attenuates to the ambient sound level; the following equation should be used:

$$\mathbf{D = Do * 10^{((Construction\ Noise\ –\ Ambient\ Sound\ Level\ in\ dBA)/\alpha)}}$$

Where D = the distance from the noise source
D_o = the reference measurement distance (50 feet in this case)
α = 25 for soft ground and 20 for hard ground. For point source noise, a spherical spreading loss model is used. These alpha (α) values assume a 7.5 dBA reduction per doubling distance over soft ground and a 6.0 dBA reduction per doubling distance over hard ground.

Example *– Project-related noise is estimated at 84 dBA, and traffic noise is estimated at 66 dBA with 40 dBA for ambient sound in a forested site (soft site). At what distance will construction noise attenuate to the ambient sound level over soft ground?*

$D = D_o * 10^{((Construction\ Noise\ –\ Ambient\ Sound\ in\ dBA)/\alpha)}$
D_o = *the reference measurement distance (50 feet in this case)*
$D = 50 * 10^{((84 – 40)/25)}$
$D = 50 * 10^{(44/25)}$
$D = 50 * 10^{(1.76)}$
$D = 50 * 57.54$
D=2,877 feet (about 0.5 miles)

To determine the distance line source traffic noise will travel before it attenuates to the ambient sound level, the following equation should be used:

$$\mathbf{D = Do * 10^{((Traffic\ Noise\ –\ Ambient\ Sound\ Level\ in\ dBA)/\alpha)}}$$

Where D = the distance from the traffic noise
D_o = the reference measurement distance (50 feet in this case)
α = 15 for soft ground and 10 for hard ground. For line source noise, a cylindrical spreading loss model is used. These alpha (α) values assume a 4.5 dBA reduction per doubling distance over soft ground and a 3.0 dBA reduction per doubling distance over hard ground.

Example *– Project-related noise is estimated at 84 dBA, and traffic noise is estimated at 66 dBA with 40 dBA for ambient sound in a forested site (soft site). At what distance will traffic noise attenuate to the ambient sound level over soft ground?*

$D = D_o * 10^{((Traffic\ Noise\ –\ Ambient\ Sound\ in\ dBA)/\alpha)}$
D_o = *the reference measurement distance (50 feet in this case)*
$D = 50 * 10^{((66 – 40)/15)}$
$D = 50 * 10^{(69/15)}$
$D = 50 * 10^{(1.733)}$
$D = 50 * 53.703$
D= 2,685 feet (0.5 miles)

To determine the distance point source construction noise will travel before it attenuates to the traffic noise level, the following equation should be used:

$$\mathbf{D = Do * 10^{((Construction\ Noise\ –\ Traffic\ Noise\ in\ dBA)/\alpha)}}$$

Where D = the distance from the noise source
D_o = the reference measurement distance (50 feet is the standard)
α = 10. For the equation where you have Construction Noise – Traffic Noise in dBA / alpha; alpha will always be 10. The reason is that construction noise will be 20 for a point source over hard ground or 25 for a point source over soft ground and traffic is a line source which is 10 for hard ground or 15 for soft ground. When you subtract the two, the result is either 25-15 = 10 or 20-10=10. Either way it will always be 10.

***Example** – Project-related noise is estimated at 84 dBA, and traffic noise is estimated at 66 dBA with 40 dBA for ambient sound in a forested site (soft site). At what distance will construction noise attenuate to the same level as traffic over soft ground?*

$D = D_o * 10^{((\text{Construction Noise} - \text{Traffic Noise in dBA})/\alpha)}$
D_o = *the reference measurement distance (50 feet in this case)*
$D = 50 * 10^{((84 - 66)/10)}$
$D = 50 * 10^{(18/10)}$
$D = 50 * 10^{(1.8)}$
$D = 50 * 63$
D= 3,154 feet (0.6 miles)

To determine what the sound level would be at this distance (3,154 feet), we would use our first equation (L_{max} = Construction L_{max} at 50 feet – 25 * Log(D/D_o) as follows:

L_{max} = *Construction* L_{max} *at 50 feet – 25 * Log*(D/D_o)
L_{max} = *84 dBA at 50 feet – 25 * Log(3154/50)*
L_{max} = *84 dBA at 50 feet – 25 * Log(63)*
L_{max} = *84 dBA at 50 feet – 25 * 1.8*
L_{max} = *84 dBA at 50 feet – 44*
L_{max} = *40 dBA*

7.1.4.3 Steps for Defining the Extent of Project-Related Noise

The following subsection provides instructions for performing a noise assessment to determine the extent of project-related noise defining the action area. Remember that noise is just one element of the project that must be considered when determining the action area. See Chapter 8 for guidance on other elements that should be considered.

The following information is provided in a step-by-step format with an accompanying example project. The noise assessment outlined below is appropriate for the vast majority of WSDOT projects.

1. **Estimate the equipment noise level for the project**. In order to estimate the noise level of project activities, it is imperative to know and understand all equipment that will be used for the specific project. The project biologist should avoid assuming the types of equipment that may be used and ask the project design or engineering office for specific information. Once all project equipment is known, use the decibel levels for common construction equipment found in Table 7-4. This table shows the noise range for similar construction equipment. If specific noise levels are not known, take the noise level shown for at least the three noisiest pieces of equipment listed in the table. Remember to use the rules of decibel addition for the final project noise level. This method provides a

conservative estimate, since not all equipment will be operating at the same time and location in most cases.

- ***Example*** – *The equipment used will be an excavator, heavy trucks, finish grader, and paver. The estimated worst-case scenario noise level for the construction equipment is: excavator, 81 dBA; dump trucks, 76 dBA; and paver, 77 dBA. The two pieces of equipment producing the least noise (dump truck at 76 dBA, and paver at 77 dBA) are added together for a difference of 1. Using the rules for decibel addition (see Table 7-5), add the 3 decibels to the highest value between the two (paver at 77 dBA) to get 80 dBA. Continuing with the rules of decibel addition, add 3 dBA to the piece of equipment with the highest noise level, the excavator at 81 dBA. Therefore, construction noise can be assumed to not exceed 84 dBA at 50 feet.*

2. **Estimate the background community or ambient sound level.** In more remote locations, background or ambient sound conditions are likely lower than traffic noise (see Section 7.1.2.1). In urban areas, community background sound may be greater than traffic noise, such as adjacent to airports. By using the information in Section 7.1.4.1, it is possible to estimate the community background sound level for the project area, based on population density.

   - ***Example*** – *The project is located on SR 101 in the vicinity of MP 216 in an undeveloped forested area. Based on the Olympic National Forest programmatic biological assessment, estimated ambient sound levels for undisturbed forested areas is 40 dBA (USDI 2003).*

3. **Estimate the traffic noise level.** A noise discipline report may be available and contain project specific traffic noise levels. If one is not available the information in Section 7.1.2.1, can be used to estimate the traffic noise level for the project area by assessing traffic. The project biologist should define the ADT and the speed limit in the project area. If the ADT and speed limit are not obvious, consult the Annual Traffic Report (<http://www.wsdot.wa.gov/mapsdata/travel/annualtrafficreport.htm>) and the Washington State Highway Log (<http://www.wsdot.wa.gov/mapsdata/roadway/statehighwaylog.htm>), respectively, for information. Take 10 percent of the ADT to find the approximate worse case number of vehicles per hour. Use the closest fit from Table 7-3 for vehicles per hour and speed to estimate the decibel level of traffic in the project area. Remember that seasonal use of the roadway and the amount of heavy truck traffic can raise or lower typical noise levels. If your project does not fit Table 7-3 or there are significant

topographic features in the area, then the project biologist should contact the WSDOT project office they are working with to ask if any acoustical monitoring has occurred in the project vicinity or in similar areas.

Example *– The project is located on SR 101 in the vicinity of MP 216 in an undeveloped forested area. The speed limit in the project area is 60 mph; traffic levels will be elevated due to seasonal use and will include heavy truck traffic. The Annual Traffic Report lists the ADT on SR 101 at MP 216 at 2,000 vehicles per day. Therefore, vehicles per hour (vph) can be estimated as 10 percent of 2,000 or approximately 200 vph. Table 7-3 lists the noise level as 66 dBA for a roadway with 250 vph and a 60 mph traffic speed, which is the best fit for the example.*

4. **Determine whether hard or soft site conditions exist.** Section 7.1.1.2 describes the difference between hard and soft site conditions. A hard site exists where noise travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. When ground cover or normal unpacked earth exists between the source and receptor, the ground becomes absorptive to noise energy and soft site conditions are present. Most project areas, other than sites adjacent to water or in developed areas having more than 90 percent concrete or asphalt, exhibit soft site conditions. For soft site conditions, add 1.5 dBA to the standard reduction factor.

   - ***Example*** *–Based on the location of the project in a forested setting, it can be assumed that soft site conditions exist. Therefore, add the additional 1.5 dBA reduction to the standard reduction factors.*

5. **Determine whether the noise is point source or line source.** Use Section 7.1.1.1 to determine whether construction noise and traffic noise are point or line source. Typically, construction noise has a point source, regardless of the activity. Even moving projects such as pavers attenuate noise in point source dynamics. Although construction activity may move, the noisy activity typically remains in one location.

   If multiple noisy activities are occurring at different locations throughout the project area, the extent of project-related noise should be described at each location. For example, pile driving could be occurring at one location in the project corridor, while pavement grinding or rock drilling may be occurring elsewhere.

   Traffic noise is almost always line source noise. The standard attenuation rate for point source noise is 6 dBA, and the standard attenuation rate for line source noise is 3 dBA. These standard attenuation rates do not take into account any reduction factors, such as soft site, vegetation, or atmospheric conditions.

- ***Example*** *– All work on the project will occur at one location, and is considered point source noise. Therefore, adding the reduction for soft site conditions, construction noise will attenuate at a rate of 7.5 dBA per doubling of distance. Traffic noise (line source) will attenuate at a rate of 4.5 dBA per doubling of distance. This attenuation rate includes the 1.5 dBA reduction for soft site conditions.*

6. **Develop an attenuation table or use the equations for solving distances.** One way to compare traffic noise attenuation, construction noise attenuation, and background sound level is to construct a table. Using the predicted levels for each of these parameters, an attenuation table should display associated distance and decibel level. In noise assessments, 50 feet is the standard distance used to describe reference sound levels. Therefore, the initial distance for known or predicted levels is 50 feet. The extent of noise from construction activity is defined as the limit where noise from construction equipment is indistinguishable from noise or sound generated by the baseline conditions, either background (such as roadway traffic0 or ambient conditions, whichever is loudest. An attenuation table thus defines the first estimate of the extent of project-related noise.

- ***Example using an attenuation table*** *– Project-related noise is estimated at 84 dBA, and traffic noise is estimated at 66 dBA with 40 dBA for ambient sound. Table 7-8 was generated using the predicted construction noise and traffic noise levels and the attenuation rates for each. In this example project, it would be safe to define the extent of project-related noise between 1,600 and 3,200 feet, because the table shows that this distance is where BOTH construction noise and traffic noise have attenuated to the ambient level (40 dBA).Therefore, at 3,200 feet, construction noise and traffic noise are not distinguishable from ambient sound level.*

- ***Example with equations for solving for distance*** *– Project-related noise is estimated at 84 dBA, traffic noise is estimated at 66 dBA, and 40 dBA is estimated for ambient sound level. Using the equation in Section 7.1.4.2 the distance construction noise attenuated to ambient levels was to 2,877 feet. Using the equation in Section 7.1.4.2 for a line source noise, the distance traffic noise attenuated to ambient levels was 2,685 feet. In this example project, the extent of project-related noise is 2,877 feet. This is only slightly farther than traffic noise extends before attenuating to ambient levels (40 dBA). Therefore, at approximately 2,700 feet, traffic* *noise is not distinguishable from ambient sound levels and at approximately 2,900 feet construction noise is not distinguishable from ambient sound levels. Therefore. the extent of project generated noise is approximately 2,900 feet.*

- *If, in the example, traffic noise was high enough to extend past 2,900 feet, then the extent of project generated noise would be to where construction noise and traffic noise attenuated to the same level, but was still above the overall ambient level.*

Table 7-8. Example noise attenuation table.

Distance from Roadway (ft)	Construction Noise (–7.5 dBA)	Traffic Noise (–4.5 dBA)	Existing Ambient Sound
50	84 dBA	66 dBA	40 dBA
100	76.5 dBA	61.5 dBA	40 dBA
200	69 dBA	57 dBA	40 dBA
400	61.5 dBA	52.5 dBA	40 dBA
800	54 dBA	48 dBA	40 dBA
1,600	46.5 dBA	43.5 dBA	40 dBA
3,200	39 dBA	39 dBA	40 dBA
6,400	31.5 dBA	34.5 dBA	40 dBA

Between 1,600 and 3,200 feet, traffic attenuates to ambient levels.

If the project occurs in a developed area, where other background sound exceeds traffic noise, the biologist can also use known background sound levels associated with the level of development, and determine when construction noise drops below the development level to identify the extent of project-related noise.

The distance calculated using the noise assessment method described above is a worst-case scenario and does not take into account naturally occurring ambient sounds such as water and wind, or topography, which can physically block noise.

Examples of two projects that might warrant a more detailed noise assessment are provided below, along with the subsequent extent of noise impacts that was calculated for each.

The first example is a blasting project. If blasting occurs along a small portion of the project corridor where work would occur, it would be most effective to develop a composite noise assessment with one element that evaluated noise generated by blasting activities and a second element that evaluated noise generated by other construction activities. This would require the biologist to complete at least two noise assessments to effectively characterize these different elements. The area influenced by blasting noise would be substantially larger than the area affected by routine construction activities and equipment. Therefore, a larger radius would define the extent of noise surrounding the blasting activities than the radius defining the extent of noise from other activities. As a result, the noise component of the action area defined for the project would display a larger circle of anticipated noise effects around blasting activities than is exhibited around the remaining corridor.

A second example of a project requiring a more detailed noise assessment is a project corridor that is surrounded by both hard and soft site conditions. For those areas surrounding the road that possess soft site characteristics, the biologist would calculate the extent of noise that is generated by proposed construction activities and equipment using an attenuation rate for soft site conditions. For those areas surrounding the road that possess hard site characteristics, the biologist would calculate the extent of noise that is generated by proposed construction activities and equipment using an attenuation rate for hard site conditions. The extent of anticipated noise impacts in soft site areas would be smaller in area than the extent that is exhibited in hard site areas. As a result, the noise component of the action area defined for the project would display a larger radius of anticipated noise effects in hard site areas than is exhibited around the remaining soft site segments of the project corridor.

There may be some specific projects that warrant a more rigorous noise assessment than is described in the procedure or outlined in the examples provided above. For example, the blasting activities described above could take place in a canyon, where surrounding topography would inhibit the transmission of noise to surrounding areas or confine noise impacts to a smaller area. For these projects, the WSDOT project manager may request that a project biologist work with WSDOT noise specialists to develop a more sophisticated analysis. Figure 7-1 below illustrates the variation in the extent of noise impacts stemming from different project activities (paving vs. blasting) as well as variation in surrounding topography.

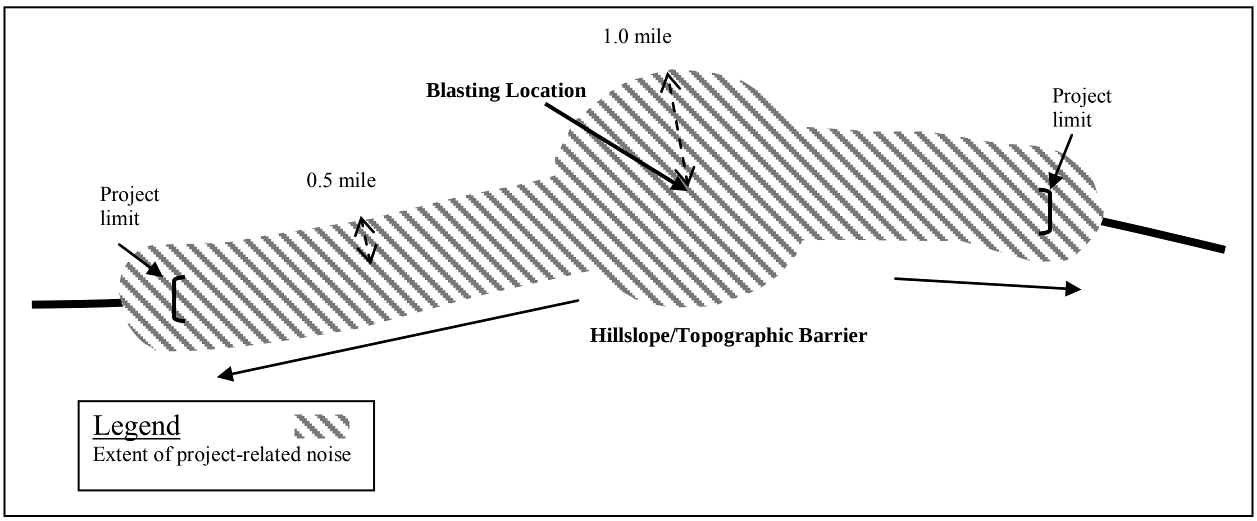


Figure 7-1. Extent of noise based on project activities and topography.

7.1.5 Species and Noise

So far, this discussion has focused on noise dynamics, generation, and prediction. The ability to identify and measure the extent of noise is only part of the assessment. The project biologist is also tasked with addressing the effects of noise on the species addressed in the BA.

7.1.5.1 How Animals Hear

Many animals hear sounds with frequencies above and/or below the range of human hearing. Some animals have ears that move and which are shaped to help localize the direction from which noise originates. Much is not known, but it is assumed that animals in general have better hearing than humans.

Not all animals respond the same way to similar sound sources, and not all individuals respond the same way within a species. Animal response to sound depends on a number of complicated factors, including noise level and frequency, distance and event duration, equipment type and condition, frequency of noisy events over time, slope, topography, weather conditions, previous exposure to similar noises, hearing sensitivity, reproductive status, time of day, behavior during the noise event, and the animals location relative to the noise source (Delaney and Grubb 2003).

Different species exhibit different hearing ranges, so appropriate noise metrics and frequency ratings should be used when possible. For in-depth noise studies and hearing assessments, noise must be measured in a way that meaningfully correlates with the target species response. In this assessment, all decibel levels have been given as frequency weighted to approximate the way that humans hear. A-weighting (dBA) deemphasizes the upper and lower portions of the frequency spectrum, while emphasizing the middle portion of the spectrum (where humans have the greatest sensitivity). An audiogram (Figure 7-2) provides examples of the hearing range sensitivity for different species.

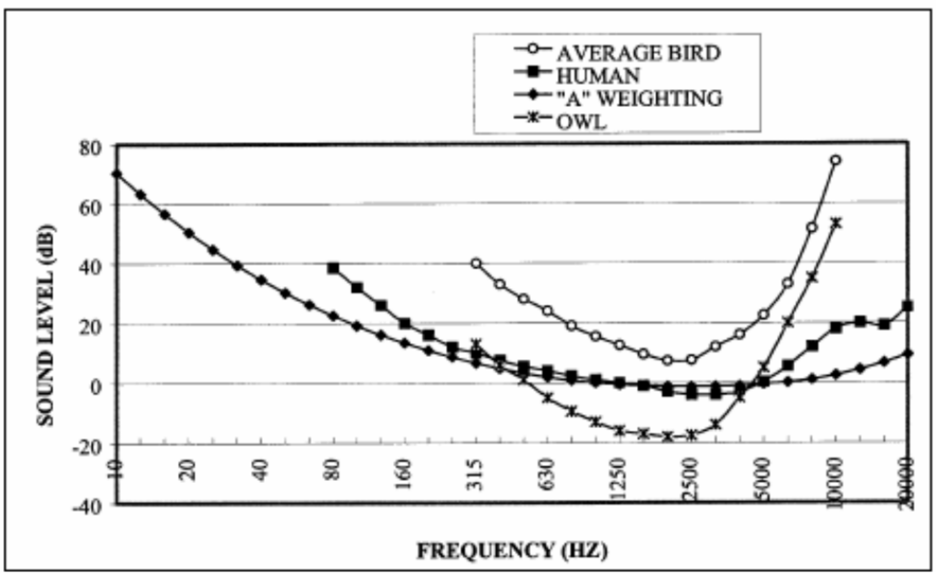


Figure 7-2. Example audiograms.

Source: Pater et al. (1999).

Notice how owls have better hearing than humans since they can detect noises in the same frequency range at lower decibel levels. An owl-weighted curve therefore emphasizes the middle frequency range where owls have the highest hearing sensitivity. The information presented in this discussion only uses A-weighted noise as a predictive factor. However, known threshold distances may provide the best available science source for understanding noise effects on species.

7.1.5.2 Threshold Distances and Effect Determinations

Threshold distances are defined as a known distance where noise at a given level elicits some response from a target species. This response can be visual, as in head-turning or flushing from a nest, or the animal may show little reaction. Particularly in birds, little or no reaction does not mean that no effect has occurred.

The U.S. Fish and Wildlife Service (USFWS) has provided WSDOT a copy of its biological opinion (BO) for the Olympic National Forest program of activities (USDI 2003). The USFWS updated Appendix 1 of the BO in September 2004. Appendix 1 provides estimates of noise levels at which incidental take of marbled murrelets and northern spotted owls is expected to occur due to harassment from noise-generating activities. The BO establishes harassment/injury levels for noise-generating activities specific to marbled murrelets and northern spotted owls.

It is important to note that the BO was provided as guidance from USFWS and is only applicable for use in certain situations because it was developed for a specific program of activity. The thresholds and effect distances were determined after factoring a suite of conservation measures specific to the project as defined by the Forest Service. Also, the analysis was specific to the habitat types found on the Olympic Peninsula. Lastly, the equipment types used by the Forest Service are often of a different type and caliber from those used on most transportation projects.

The threshold levels described in the BO can be used as a tool to assist the biologist in certain situations in making effect determinations for marbled murrelets and northern spotted owl. By using the information above to identify the project-related noise extent, the biologist can determine the distance at which the established threshold levels are located in relation to suitable habitat or documented species.

Harassment distance is the distance from an activity at which incidental take occurs due to disturbance. Within the BO, harassment distances and effect determinations for activities including but not limited to blasting, pile driving[2], and heavy equipment operation are defined (see Chapter 13 for effect determination guidance). In a previous BO for the Olympic National Forest, the USFWS used a standard 0.25-mile distance from most noise generating activities. In this BO, threshold distances in most cases are reduced significantly, based on the noise assessment provided in Appendix 1 of the BO.

The analysis determined noise levels at a distance by using a 7.5 dBA doubling distance reduction from noise-generating activities. They estimated the noise-only harassment/injury threshold for murrelets and owls is approximately 92 dBA at nest sites. This level does not

[2]. It is important to note that the pile sizes and types analyzed in the Forest Service opinion are not similar to those used on most transportation projects. In many cases they were evaluating the use of small-diameter and/or wood piles.

change throughout the analysis. Disturbance thresholds were estimated at 70 dBA, and detectability thresholds were estimated at 44 dBA. For the biologist's purpose, this threshold level applies in similar settings to that found in the Olympic National Forest – generally undeveloped, high precipitation, forested areas. The disturbance and detectability thresholds can vary, depending on the background sound level. The process that was used to determine the noise-only detectability, alert, disturbance, and harassment/injury threshold distances is outlined below:

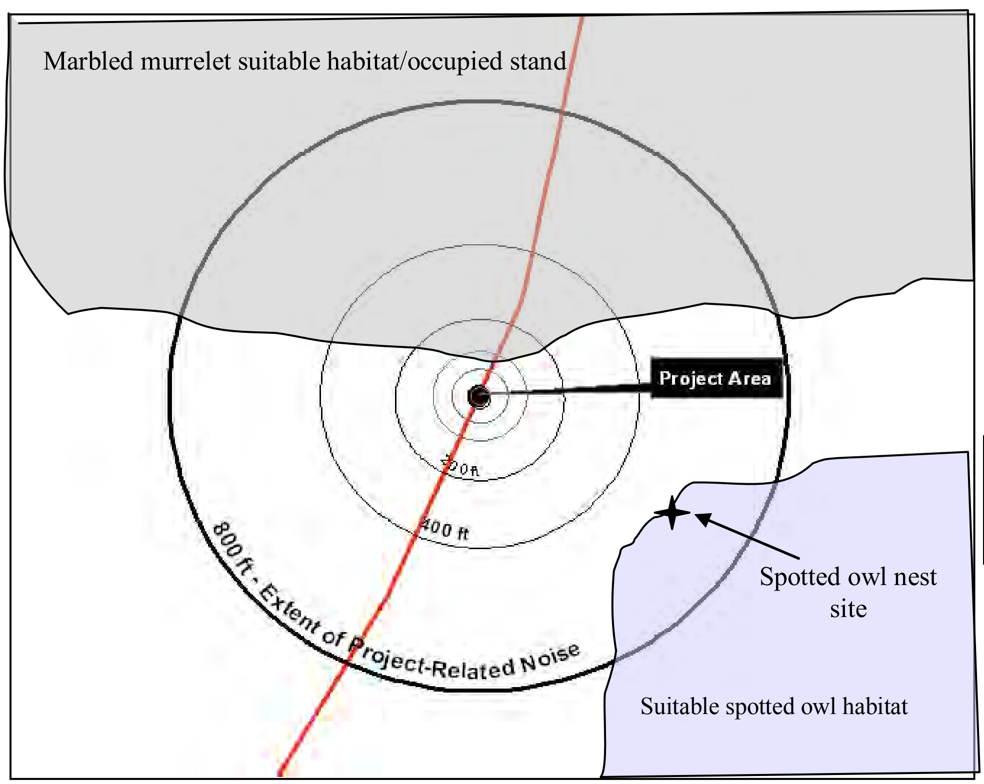
- ***Noise-only detectability threshold*** (where the noise is detectable, but a murrelet or spotted owl does not show any reaction). The detectability threshold was identified as being 4 dB above the baseline sound level. For example, in the Olympic National Forest biological opinion, baseline sound levels were identified at 40 dBA; therefore the detectability threshold was 44 dBA. This number varies based on baseline sound levels. Dooling and Hulse (1989) noted that 16 species of birds showed an average sensitivity of 4 dBA to detect a noise (USDI 2003).
- ***Noise-only alert and disturbance thresholds*** (alert is where the murrelet or spotted owl shows apparent interest by turning the head or extending the neck; disturbance is where the murrelet or spotted owl show avoidance of the noise by hiding, defending itself, moving the wings or body, or postponing a feeding). These threshold levels could not be documented with any precision, so they were subjectively placed between the detectability threshold and the harassment/injury threshold. The alert threshold is 57 dBA and the disturbance threshold is defined as 70 dBA (both L_{max} metrics). These thresholds will change depending on the baseline sound level and do not widely apply.
- ***Noise-only harassment/injury threshold*** (where the murrelet or spotted owl is actually injured, defined as an adult flushed from the nest or the young missing a feeding). This distance was estimated using known data from several studies that documented noise-only flushes for several bird species. Based on the results of the studies, the noise-only harassment/injury threshold is 92 dBA (L_{max} based upon maximum decibel levels reported in Canter 1997 as cited in USDI 2003). The detectability, alert, and disturbance threshold will differ as baseline sound differs, but this 92 dBA level remains constant.

7.1.5.3 Extent of Project-Related Noise versus Effects to Species

One of the biggest mistakes made in writing a BA is to define the action area in terms of the extent of impacts on species rather than the zone of impact for the physical, chemical, and biological effects of the action.

To illustrate the concept of the project-related noise extent versus impacts on species, this section combines the noise analysis information from Section 7.1 through Section 7.1.4.1 with the thresholds used in the Forest Service's BO level information, to determine the effects on species and reach an effect determination.

In Figure 7-3, the project area is the dot in the center of the figure. The concentric circles show the noise attenuation distances for construction and traffic noise. The two small tables with the figure show the noise levels and distances from the example for construction and traffic noise attenuation. Also displayed are a spotted owl nest site and suitable habitat, and marbled murrelet suitable habitat identified as an occupied stand. These locations are placed only for the purposes of the example.



Construction dBA	
200 feet	83 dBA
400 feet	75.5 dBA
800 feet	68 dBA

Traffic dBA	
200 feet	77 dBA
400 feet	72.5 dBA
800 feet	68 dBA

Figure 7-3. Example project area and species occurrence.

The extent of project-related noise was determined to be 800 feet. This distance is shown in these figures as the heavier line. For this example, assume that noise is the farthest-reaching impact from construction activities; therefore, this distance represents the project action area.

- **Northern spotted owl** – The spotted owl nest site is located about 600 feet from the project area. Based on the example model above and using the equation for solving for construction noise level at a specific distance, the predicted decibel level from project-related noise at the nest is about 71 dBA and traffic related noise is about 70 dBA. The construction noise is above the somewhat arbitrary disturbance threshold of (70 dBA), and below the harassment/injury threshold of 92 dBA. However, at 600 feet from the project area, owls would be exposed to background sound levels from traffic at about 70 dBA. Because the detectability threshold is 4 dBA above background, spotted owls at the = nest site would not be able to detect noise levels below 74 dBA. Therefore, even though the nest is located in a zone where an owl could hear and show disturbance from the noise in the absence of traffic, project-related noise is unlikely to be detected at the nest and; therefore, noise disturbance from construction activities is not expected to delay a feeding attempt or cause avoidance behavior, and will not reach the level of causing harassment or injury (92 dBA) as defined in the Forest Service's BO. This project example also assumes that the nest is not in line-of-sight of construction activities. The project biologist should always address the potential for visual disturbance as well.

- **Marbled murrelet** – Suitable murrelet habitat exists about 80 feet from construction activity. In the absence of a survey to protocol, the project biologist must assume that suitable habitat is occupied habitat. By the time noise from construction enters suitable murrelet habitat, levels have attenuated to 93 dBA. This level is above the harassment/injury threshold of 92 dBA as defined in the Forest Service's BO. At this point, noise levels in suitable habitat would be high enough for harassment or injury to occur to any marbled murrelets potentially using the habitat, and an adverse impact would be expected.

7.2 Underwater Noise

In-water work activities contribute to noise in the marine and freshwater environments. Underwater noise from pile driving activities is an issue of concern for both NOAA Fisheries and the U.S. Fish and Wildlife Service (referred to here as the Services). Recent fish kills that resulted from in-water pile driving activities in Puget Sound, San Francisco Bay, and British Columbia, Canada, raised the Services' level of concern.

Noise behaves in much the same way in air as it does in water. The information and concepts presented here apply to both fresh and saltwater environments. Water currents bend noise waves upward when propagated into the current and downward downstream when observed over long distances. Noise waves bend towards colder denser water. Bottom topography and underwater structures can block, reflect, or refract noise waves.

Underwater noise levels are measured with a hydrophone, or underwater microphone, which converts noise pressure to voltage, which is then converted back to pressure, expressed in

Pascals (Pa), pounds per square inch (psi), or decibels (dB).[3] The current standard distance for measuring source noise levels is 10 meters from the source, where the source and receiver are within line of sight of each other. As a general guideline, noise levels measured more than approximately 50 meters from the source may result in far field effects. Far field effects may result in calculations of a higher noise level at the receiver than would be measured in real time. Conversely, measurements taken too close to the source may result in near field effects (Laughlin 2008), which may also result in inaccurate noise level calculations at the receiver.

Noise levels measured in air are typically used to assess impacts on humans and thus decibels are weighted (dBA) to correspond to the same frequency range that humans hear. Noise levels underwater are not weighted and thus measure the entire frequency range of interest, which may extend below and above the audible range of many organisms (dB).

Several descriptors are used to describe underwater noise. Two common descriptors are the instantaneous peak sound pressure level (dB_{peak}) and the Root Mean Square (dB_{RMS}) pressure level during the impulse, sometimes referred to as the peak and RMS level respectively. The peak pressure is the instantaneous maximum overpressure or underpressure observed during each pulse and can be presented in Pascals (Pa) or SPL in decibels (dB) referenced to a pressure of 1 micropascal (dB re: 1 μPa). The RMS level is the square root of the energy divided by the impulse duration. This level is the mean square pressure level of the pulse. It has been used by NMFS to describe disturbance-related effects (i.e., harassment) to marine mammals from underwater impulse-type noises. When evaluating potential injury impacts to fish, peak sound pressure (dB_{peak}) is often used.

It is not possible to convert peak levels to RMS levels directly, but a conservative rule of thumb can be applied in noise assessments. Peak levels are generally 10 to 20 dB higher than RMS levels. To convert from peak to RMS, subtract 10 dB. This likely overestimates the RMS value, but enables the assessment to remain as conservative as possible. Likewise, to convert from RMS to peak, add 20 dB. This again may overestimate the actual peak noise level, but will provide a conservative estimate.

Sound Exposure Level (SEL) is often used as a metric for acoustic events and is often used as an indication of the energy dose. SEL is calculated by summing the cumulative pressure squared (p^2), integrating over time, and normalizing to 1 second. This metric accounts for both negative

[3]. Measurements are typically recorded electronically for analysis later. Pascals, or psi, can easily be converted to decibels (dB). To convert sound pressure energy to dB in air or water we use the same formula:

$$dB = 20 \log(p/pref)$$

Where dB is decibels, p is the pressure in micropascals (pascal multiplied by 10^6), pref is a reference pressure. When converting air pressure levels a reference pressure of 20 micropascals is used. The 20 micropascal reference for sound in human studies was selected because it is near the threshold of hearing at 1kHz for the average young person. When converting underwater pressure levels a somewhat arbitrary reference pressure of 1 micropascal is used. Thus in many reports in the literature, underwater decibels are reported as decibels re: 1 micropascal, indicating that the decibels are referenced to 1 micropascal. All underwater sound pressure levels given in this chapter are in decibels (dB) referenced to 1 micropascal (μPa).

and positive pressures because p^2 is positive for both and both are treated equally in the cumulative sum of p^2 (Hastings and Popper, 2005). The units for SEL are dB re: 1 μPa^2 sec.

7.2.1 Noise Generation, Transmission, and Reduction

Transmission loss (TL) underwater is the accumulated decrease in acoustic intensity as an acoustic pressure wave propagates outwards from a source. The intensity of the source is reduced with increasing distance due to spreading. Spreading can be categorized into two models, spherical spreading and cylindrical spreading models.

7.2.1.1 Transmission Loss Calculations for Underwater Noise Levels

Spherical (free-field) spreading occurs when the source is free to expand with no refraction or reflection from boundaries (e.g., the sediment or water surface). The TL for spherical spreading is defined by the formula:

$$\mathbf{TL = 20\ log(R)}$$

where R is the range or distance from the source. Spherical spreading results in a general 6 dB decrease in the intensity of the noise per doubling of distance.

Cylindrical spreading applies when noise energy spreads outwards in a cylindrical fashion bounded by the sediment and water surface. Cylindrical spreading is defined by the formula:

$$\mathbf{TL = 10\ log(R)}$$

This results generally in 3 dB per doubling of distance transmission loss of underwater noise. However, many construction projects produce noise in shallow water, and reflections from the sediment or water surface can reduce spreading considerably. Because of the complexity of these reflections it is difficult to define TL. Since noise energy is not perfectly contained by reflection and refraction most experts agree that the true spreading is often somewhere between 3 and 6 dB per doubling of distance, or approximately 4.5 dB per doubling of distance (Vagle 2003).

Currently, the Services use the practical spreading loss calculation as described by Davidson (2004) and Thomsen et al. (2006), where:

$$\mathbf{TL = 15Log(R_1/R_2)}$$

Where:

- R1 is the range or distance at which transmission loss is estimated.
- R2 is the range or distance of the known or measured sound level

Conversely the distance to where the source sound level drops off to some pre-determined sound level (e.g., the background sound level) can be calculated by rearranging the terms in the equation above giving:

$$R_1 = R_{2*}10^{(TL/15)}$$

Where:

- TL = the difference between the source sound level and the background or other sound level at some distance.

This calculation assumes that noise energy decreases at a rate of 4.5 dB per doubling of distance, which is in between the spherical (6 dB) and cylindrical (3 dB) calculation. The complete equation for transmission loss includes a linear term in addition to the geometric term. A complete transmission loss equation might look like:

$$TL = 15 \log(R_1/R_2) + \alpha R$$

Where:

- αR is the linear absorption and scattering loss.

The linear term will have a greater influence on transmission loss 1,000 meters beyond the source. There is not common agreement on what should be used for the alpha term in the equation above, particularly for shallow water environments. Therefore, the linear term should be ignored for the present time until a decision can be made on the appropriate value to be used for alpha.

Illingworth and Rodkin (pers. comm. 2003) state that the underlying characteristic of transmission loss for pile driving in marine environments is spherical spreading; however, like propagation in air, a number of other factors, such as temperature gradients and currents, modify this characteristic. The common occurrence of decreasing temperature with depth can create significant shadow zones (noise refracts or bends towards the colder deeper water as it does in air) where the SPL can be as much as 30 dB lower than that from spherical spreading. In shallow water (less than 200 meters depth), reflections from the surface and bottom combine in such a way that the noise level TL, transitions from spherical spreading of 6 dB per doubling of distance to cylindrical spreading of 3 dB per doubling of distance. Where this transition occurs depends on the distance from the source, water depth, acoustic wavelength, and the reflective properties of the bottom and surface conditions. Thus, underwater noise propagation is highly variable. Monitoring data from some pile driving projects indicate that the actual spreading loss is intermediate between cylindrical and spherical spreading (Reyff 2003; Thomsen et al. 2006) while other data indicates that the actual spreading loss is closer to spherical spreading (Laughlin 2010a[4], 2010b[5]). Therefore, until a better spreading model can be developed and agreed on a practical spreading model, as described by Davidson (2004) and Thomsen et al. (2006) is most appropriate.

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[4] Laughlin, Jim. 2010a. Underwater sound levels associated with driving steel piles at the Vashon ferry terminal. WSDOT Report.

[5] Laughlin, Jim. 2010b. Vashon Ferry Terminal Test Pile Project – Vibratory Pile Monitoring Technical Memorandum. WSDOT – Tech Memo.

7.2.1.2 Noise Reduction Factors

Hydrographic Conditions that Affect Noise Transmission

In a current or strong tidal flux, noise propagated into the current would be refracted toward the surface where it would be quickly attenuated. However, this would depend on the velocity of the current and would occur on a scale of several hundred feet or more. This has not been researched adequately to make definitive determinations.

The water depth in which frequencies propagate must be greater than one-quarter the wavelength or $h = \lambda/4$ where h = water depth and λ = wavelength (Urick 1983). Wavelength is determined by $\lambda = c/f$ where f = frequency in Hz and c = speed of noise in water (approximately 5,000 feet/sec). Since the dominant frequencies generated in pile driving are between 50 and 1,000 Hz, most of the energy is not propagated in water depths of 0.4 meters (1.3 feet) or less. However, some noise propagates through the sediment, especially the harder sediments, such as clay and rock, escaping into the water column somewhere else (albeit at a lower level than the source) through *sound flanking*.[6] Sound flanking is a common occurrence and has been observed by Burgess and Blackwell (2003) and WSDOT (2004d).

Bottom Topography

The method of determining how noise spreads as it moves away from the source can be difficult and site specific. It is dependent on sediment types, bottom topography, structures in the water, slope of bottom, temperature gradients, currents, and wave height. In the Puget Sound region, generally the sediments are relatively soft and the bottom slopes away from the shore relatively quickly. Depending on location and season, there can also be a relatively strong tidal flux in Puget Sound. Therefore, it is clear that general conclusions about spreading cannot be drawn without the likelihood of violating some of the site-specific assumptions listed above.

River Sinuosity

Noise propagation in rivers is limited by the sinuosity of a system. For example, where a river bends, noise is unlikely to propagate. A line-of-sight rule, meaning that noise may propagate into any area that is within line-of-sight of the noise source, is used to determine the extent of noise propagation in river systems.

7.2.2 Baseline Underwater Sound Conditions

Existing underwater sound levels can serve as a baseline from which to measure potential disturbance impacts associated with project activities. Both ambient or natural noise sources and mechanical or human generated background sound contribute to the baseline sound conditions of a project site.

[6]. *Sound flanking* refers to paths by which sound travels around an element, such as in water surrounding a piling. For example, a sound generated by pile driving can be flanked to another location by the ocean floor if the substrate is relatively uniform and uninterrupted from one location to another.

7.2.2.1 Ambient or Background Sound Levels

There are numerous contributing sources to background marine sound conditions. Sound levels produced by natural sources include snapping shrimp (71 dB) (Urick 1983), lightning strikes (260 dB), waves breaking, and rain on the ocean surface. Sound levels produced by human or mechanical sources include large tankers and naval ship engines (up to 198 dB) and 180+ dB for depth sounders (CRS Report 95-603 1995; Heathershaw et al. 2001). Commercial sonar devices operate in a frequency range of 15 kHz to 200 kHz and in an acoustical range of 150 to 215 dB (Stocker 2002). These levels are maximum source levels.

At the Bainbridge Island Ferry Terminal, underwater background sound levels were recorded as 151 dB peak (150 dB to 160 dB peak with construction equipment) (Laughlin 2005a[7]), but the Friday Harbor Ferry Terminal was between 131 dB to 136 dB peak (133 dB to 140 dB peak with construction equipment) (Laughlin 2005b[8]). In the vicinity of the Mukilteo Ferry Terminal, broadband background was recorded as 136 dB_{RMS} to 137 dB_{RMS} (Laughlin 2007[9]). Background levels were recorded north of the Mukilteo ferry terminal using high sensitivity hydrophones to be 135 dB_{RMS} at the 90th percentile level and 124 dB_{RMS} at the 50th percentile level (McGillivray et al. 2007[10]). Broadband background sound levels in Hood Canal (near the now decommissioned WSF Lofall-Southpoint ferry terminal) vary between 115 dB_{RMS} and 135 dB_{RMS} (Carlson et al. 2005)[11] . In a study conducted in Haro Strait, San Juan Islands, data showed that the broadband ambient half-hourly SPL in Haro Strait ranged from 95 dB to 130 dB (Veirs and Veirs 2005).[12] This same study indicated that 2-second SPL averages are lowest in the winter, slightly higher during summer nights, and highest during summer days as a result of small boat traffic.

For areas near ferry terminals or other anthropomorphic activity, best available data indicates that broadband background sound levels in Puget Sound in the near shore areas (i.e., within 1 kilometer of shoreline with frequent human activities and shipping or ferry lanes) are approximately 135 dB_{RMS}. Background measurements from human activities collected beyond

[7] Laughlin, J. 2005a. Underwater sound levels associated with pile driving at the Bainbridge Island Ferry Terminal Preservation Project. Prepared by Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA. November 2005.

[8] Laughlin, J. 2005b. Underwater sound levels associated with restoration of the Friday Harbor Ferry Terminal. Prepared by Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA. May 2005.

[9] Laughlin, J. 2007. Underwater sound levels associated with driving steel and concrete piles near the Mukilteo Ferry Terminal. Prepared by Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA. March 2007.

[10] MacGillivray, A., Ziegler, E. and Laughlin, J. 2007. Underwater Acoustic Measurements from Washington State Ferries 2006 Mukilteo Ferry Terminal Test Pile Project. Technical Report prepared by JASCO Research, Ltd. for Washington State Ferries and Washington State Department of Transportation, 27 pp.

[11]. Carlson, T.J., D.A. Woodruff, G.E. Johnson, N.P. Kohn, G.R. Plosky, M.A. Weiland, J.A. Southard, and S.L. Southard. 2005. Hydroacoustic Measurements During Pile Driving at the Hood Canal Bridge, September through November, 2004. Battelle Marine Sciences Laboratory, Sequim, Washington.

[12] Veirs, V.R. and S.R. Veirs. 2005, in preparation. Measuring orca call intensity with a shallow coastal fixed array.

this distance in the San Juan Islands indicate that 120 dB_{RMS} is the approximate broadband ambient sound level.

WSDOT has recently acquired hydrophones for determining background sound levels at Washington State ferry terminals and in the vicinity of other WSDOT facilities. Data collected as part of this effort will help to more accurately characterize background conditions throughout the Puget Sound region. Background sound levels in deep freshwater lakes or deep slow moving rivers are approximately 135 dB_{RMS}, similar to marine levels near developed shorelines. In shallow (1 foot deep or less), fast moving rivers, the ambient sound levels are louder due to the water moving over rocks and boulders and the wave action at the surface. Background levels are estimated at 140 dB_{RMS} in these systems (Laughlin 2005).

7.2.3 Underwater Construction Noise

Although there are many sources of noise in the underwater environment, the most common sources of noise associated with construction activities are impact hammers. Underwater noise from pile driving is generated using different types and diameters of piles, types of hammers, and by driving the piles into different types of substrates. Each configuration can produce different noise levels and waveform characteristics.

Noise generated by impact pile driving is impulsive in nature. Impulsive noises have short duration and consist of a broad range of frequencies. Impulsive waveforms are characterized by a rapid pressure rise time (the time in milliseconds it takes the wave form to rise from 10 percent to 90 percent of its highest peak) that occurs within the first few milliseconds followed by rapid fluctuation (underpressure and overpressure) about the ambient pressure.[13] Although other methods such as peak-to-peak or zero-to-peak are used by some researchers to define rise time the method of calculating rise time noted above has become the standard for pile driving waveforms. Although there is no definitive correlation between rise time and injury to fish it is thought that a rapid rise time may cause injury.

7.2.3.1 Pile Installation Equipment

There are five pile-driving hammer types that are commonly used. Vibratory hammer, diesel hammer, air or steam hammer, hydraulic hammer, and drop hammer used for smaller timber piles. Wave forms generated by each of these hammer types are described below.

Vibratory hammers vibrate the pile into the sediment by use of an oscillating hammer placed on top of the pile. The vibratory action causes the sediment immediately surrounding the pile to

[13]. The total duration of the impulse varies based on several factors, which include the force applied to the pile, the nature of the pile (i.e., wood, concrete, or steel as well as diameter) and the substrate into which the pile is being driven. In general, most of the energy associated with each impulse occurs within the first 30 to 50 milliseconds. Recent measurements of underwater sound generated by impact pile driving have shown that most of the energy is contained in a frequency range between approximately 25Hz and 1.6 kHz. Within this frequency band the highest energy densities are found between 50 and 350 Hz (Reyff et al. 2002).

liquefy and the pile can be driven through the sediment. In some cases piles can be driven by vibratory hammers to a depth where they can reach load bearing capacity, but the bearing capacity must be tested with the use of an impact hammer. This is referred to as proofing. To proof a pile it is struck with an impact hammer until the bearing capacity can be measured. This may take just a few strikes or several strikes depending on site-specific characteristics.

Peak noise levels can exceed 180 dB; however, the rise time is relatively slow (Figure 7-4). Vibratory driving noise levels are generally 10 to 20 dB lower than impact hammer driving. Vibratory installation of steel piles in a river in California resulted in sound pressure levels that were not measurable above the background noise created by the current (Reyff 2006).

Impacts on fishes or other aquatic organisms have not been observed in association with vibratory hammers. This may be due to the slower rise time and the fact that the energy produced is spread out over the time it takes to drive the pile. As such, vibratory driving of piles is generally considered less harmful to aquatic organisms and is the preferred method.

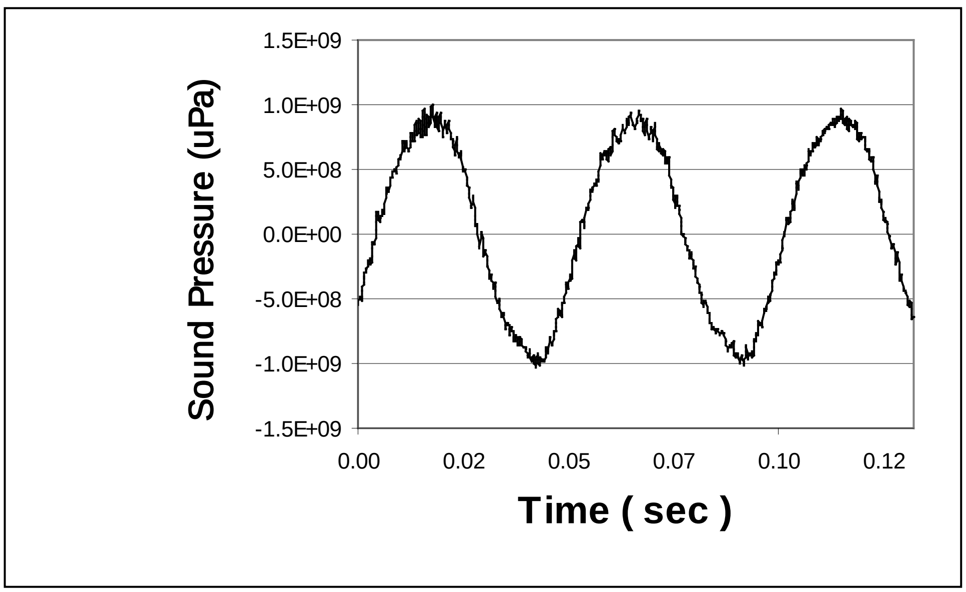

Figure 7-4. Typical vibratory hammer wave form.

Air or steam-driven impact hammers use air to lift a heavy piston and then use gravity to drop the piston onto the top of the pile. The height of the piston can be varied to allow more potential energy to transfer to the piston and then transfer as kinetic energy into the pile. Air hammers produce underwater noise waveforms with each pile strike that are similar to diesel hammers (Figure 7-5). Therefore, noise levels and rise time are similar for air hammers and diesel hammers.

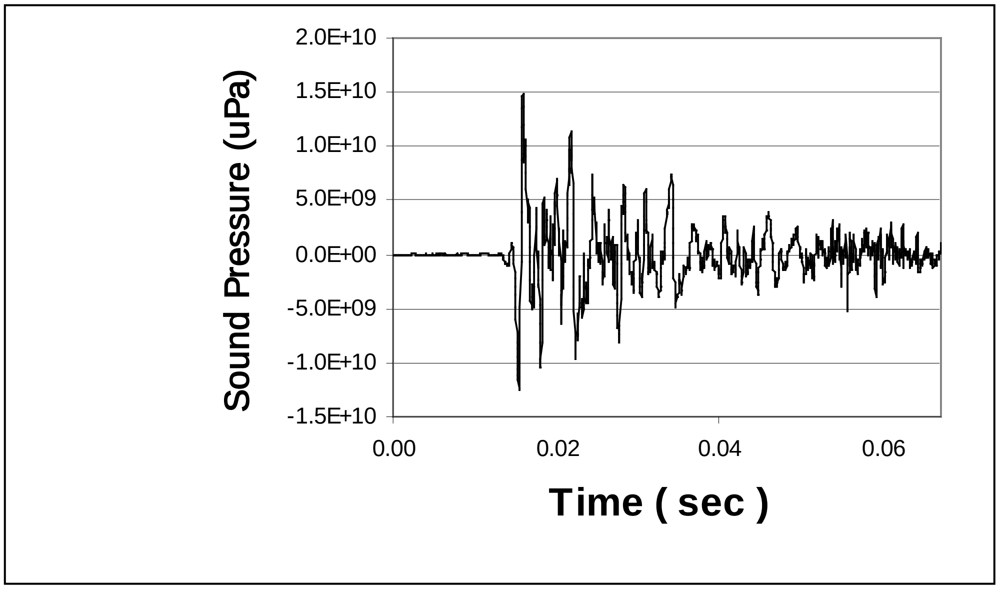

Figure 7-5. Typical air hammer wave form for a single pile strike.

Diesel-driven impact hammers ignite diesel fuel to lift a heavy piston and then use gravity to drop the piston onto the top of the pile. The height of the piston can be varied somewhat by varying the amount of diesel fuel going into the combustion chamber. Diesel hammers produce underwater noise waveforms with each pile strike that are similar to air hammers (Figure 7-6).

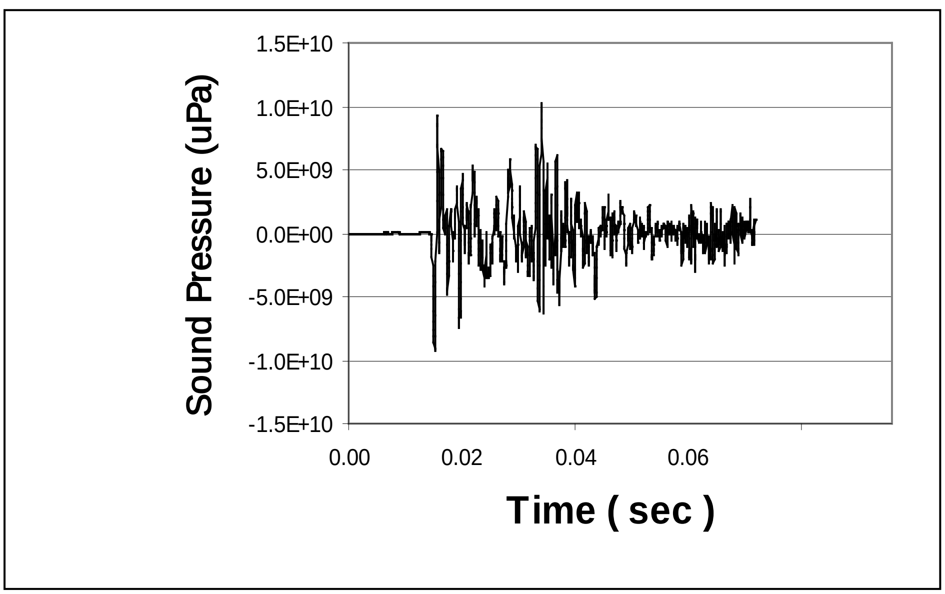

Figure 7-6. Typical diesel hammer wave form for a single pile strike.

Hydraulic driven impact hammers use hydraulics to lift a heavy piston and then use gravity to drop the piston onto the top of the pile. In addition, with some hydraulic hammers, hydraulic pressure is used to drive the hammer into the pile instead of using gravity. Hydraulic hammers produce a somewhat different waveform signature with a much more rapid rise time

(Figure 7-7). The diesel hammer is the recommended hammer to use based on rise time data gathered from the Friday Harbor Ferry Terminal Study.

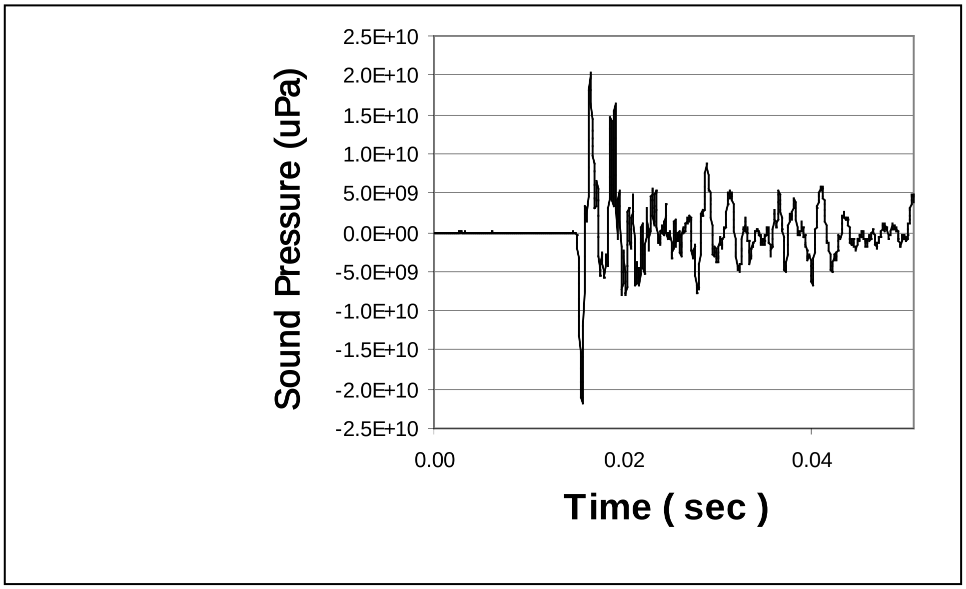

Figure 7-7. Typical hydraulic hammer wave form for a single pile strike.

7.2.3.2 Different Pile Types

The size and type of pile also affect the sound generated by pile-driving activities. There are three types of piles typically used in transportation projects: timber, concrete, and steel. Sound pressure levels associated with each of these types of piles are summarized in Table 7-9. Sound levels from projects within Washington State are used when available. The sound levels are denoted as either peak, RMS, or SEL; and all are unattenuated values and measured at 10 meters from the pile unless otherwise noted.

Other considerations include:

- Peak levels are generally 10 to 15 dB higher than RMS levels.
- Peak pressures occur between 1 millisecond (msec) very close to the pile and 5 to 6 msec after the strike at a distance of 20 meters from the pile.
- The greater the pile surface exposed under the water, the more acoustic energy radiates. Shallower water (e.g., water less than about 2 feet deep) does not propagate noise energy effectively, especially at lower frequencies (Urick 1983).

Table 7-9. Sound pressure levels associated with pile types.

Pile Type	Sound Level (single strike)		
Wood piles:[14]	180 dB_{peak}	170 dB_{RMS}	160 dB SEL
Concrete piles:[15]	192 dB_{peak}	176 dB_{RMS}	174 dB SEL
Steel H-piles[16]:	190 dB_{peak}	175 dB_{RMS}	155 dB SEL
12-inch steel piles:	208 dB_{peak}[17]	191 dB_{RMS}[18]	175 dB SEL[19]
14-inch steel piles:	195 dB_{peak} @ 30 m[20]	180 dB_{RMS} @ 30 m[41]	
16-inch steel piles[21]:	200 dB_{peak}@ 9 m	187 dB_{RMS} @ 9 m	
24-inch steel piles[22]:	212 dB_{peak}	189 dB_{RMS}	181 dB SEL
30-inch steel piles[23]:	212 dB_{peak}	195 dB_{RMS}	186 dB SEL
36-inch steel piles[24]:	214 dB_{peak}	201 dB_{RMS}	186 dB SEL
60-inch dia. steel piles[45]:	210 dB_{peak}	195 dB_{RMS}	185 dB SEL
66-inch dia. steel piles[45]:	210 dB_{peak}	195 dB_{RMS}	
96-inch dia. steel piles[45]:	220 dB_{peak}	205 dB_{RMS}	195 dB SEL
126-inch dia. steel piles[25]:	213 dB_{peak} @ 11 m	202 dB_{RMS} @ 11 m	
150-inch dia. steel piles[26]:	200 dB_{peak} @ 100 m	185 dB_{RMS} @ 100 m	

[14]. Timber piles, 12-inches in diameter, have been measured underwater by Illingworth and Rodkin and are published in the draft Pile Driving Compendium which as of the date of this update has not yet been released as final. Illingworth and Rodkin (2004) have compared the shape of the sound wave between steel piles and timber piles and found that a timber pile produced a more 'rounded' wave than a steel pile. This means that although the peak sound levels may be similar, the waveform appears more stretched out for a timber pile than for a steel pile and the rise time is relatively slower. A slower rise time means that the shock wave produced with each pile strike is not as severe presumably resulting in less damage to the fish. The effect is similar to the difference between a push and a punch.

[15]. Concrete piles measured had 36-inch diameter and 4 –inch wall thickness (~419 lbs/ft weight per unit length (MacGillivray et al. 2007). Concrete 24-inch diameter piles have been measured by POV, and sound levels range between 190 dBpeak and 205 dBpeak (DesJardin 2003 pers. comm..). While there have been no documented fish kills with the installation of concrete piles, the Services may require sound mitigation strategies or monitoring because of the lack of formally documented effects (CalTrans 2003 personal communication).

[16]. Illingworth and Rodkin, pers. comm. (2004). Illingworth and Rodkin (2004 personal communication) measured 10-inch steel H-piles in a slough approximately 6 feet deep at 10 meter distance from the pile to range between 180 – 195 dB (160-177 dB RMS). They also measured 10-inch steel H-pile at Noyo Bridge with peak levels at 180 dB (165 dB RMS) at 30 meters from the pile. An H-pile driven on shore next to the water produced peak levels in the water of 170-175 dB (155-162 dB RMS) at 23 meters from the pile. The measurements at Noyo Bridge were highly variable due to the shallow water.

[17]. Illingworth and Rodkin (2002).

[18]. CalTrans (2003 personal communication) has measured the sound energy emanating from driving 12-inch diameter steel piles to range between 180 – 190 dB, and 14-inch diameter steel piles to range between 195 and 200 dB. Vibratory driving has been shown to be 10 – 20 dB lower than impact driving steel piles of similar diameter (CalTrans 2003 personal communication).

[19] Laughlin (2006).

[20]..Reyff (2003).

[21].Laughlin, Jim. 2004. Underwater Sound Levels Associated with the Construction of the SR 240 Bridge on the Yakima River at Richland. WSDOT, Office of Air Quality and Noise, Seattle, WA. September 2004. 33 pages.

[22].Laughlin (2005a).

[23].Laughlin (2005b).

[24].Laughlin (2007).

[25].Reyff (2003).

[26].Reyff (2003).

7.2.3.3 Noise Reduction Strategies

Various measures have been developed to reduce underwater noise generated by pile driving. These include air bubble curtains (confined or unconfined), temporary noise attenuation piles, air filled fabric barriers, and isolated piles or cofferdams. An air bubble curtain is a device used during pile driving that infuses the area surrounding piles with air, thereby generating a bubble screen. The purpose is to reduce peak underwater sound pressure levels (SPLs), thereby reducing potential adverse effects to aquatic organisms.

The components of a bubble curtain typically include a high volume air compressor, primary and secondary feed lines, and air distribution manifolds. Longmuir and Lively (2001) recommended that manifolds should have 1/16-inch air release holes every 3/4-inch along their entire length (Figure 7-8). The Services currently recommend basing bubble curtain design on that described in Longmuir and Lively (2001). The air distribution manifolds are placed surrounding the piling below the water surface where the pile meets the sediment. An effective bubble curtain system should distribute air bubbles that completely surround the perimeter of a pile to the full depth of the water column. Maintaining the optimal size of the bubbles, based on their resonant frequency, greatly enhances the noise attenuation of the bubble curtain (Vagle 2003).

In areas where currents exist, where the seafloor or substrate is not level, or piles are being driven at an angle other than 90 degrees to the water surface, the size or number of manifolds should increase to provide coverage throughout the water column. In some of these cases, particularly where currents can move the curtain away from the pile, unconfined bubble curtains may prove ineffective, and a confined system may be required.

Proper design and implementation are key factors in bubble curtain effectiveness.for reducing SPL. Studies on the effectiveness of bubble curtains for reducing noise pressure waves have found varied results. MacGilivray et al. (2007) and Reyff (2003) reviewed previous reports, and also conducted a study on the use of bubble curtains and their reduction of noise pressure waves. In previous studies, Reyff (2003) found that bubble curtains resulted in a 0 to 10 dB reduction in RMS. While monitoring pile driving of three large piles (inside diameter of 8 feet, outside diameter of 8.5 feet), bubble curtains reduced peak pressures from 6 to over 20 dB and RMS values from 3 to 10 dB. Thorson and Reyff (2004) found similar results with a reduction of from 5 to 20 dB in peak SPLs. Vagle (2003) studied the underwater effects of pile driving at four locations in Canada. This study reported reductions of between 18 dB and 30 dB when using a properly designed bubble curtain.

Reyff et al. (2002) evaluated the effectiveness of an isolated pile (IP) technique using a confined bubble curtain system. The IP was 3.8 meters in diameter with the interior coated with 2.54 centimeter closed cell foam. In this type of bubble curtain system, the IP surrounds the actual driven pile, and contains the bubble flow. The IP and bubble curtain system provided a dramatic reduction in both peak pressures and RMS levels. Peak pressures were reduced by 23 to 24 dB and RMS levels were reduced by 22 to 28 dB. Most of the reduction in noise energy occurred at frequencies above 100 Hz.

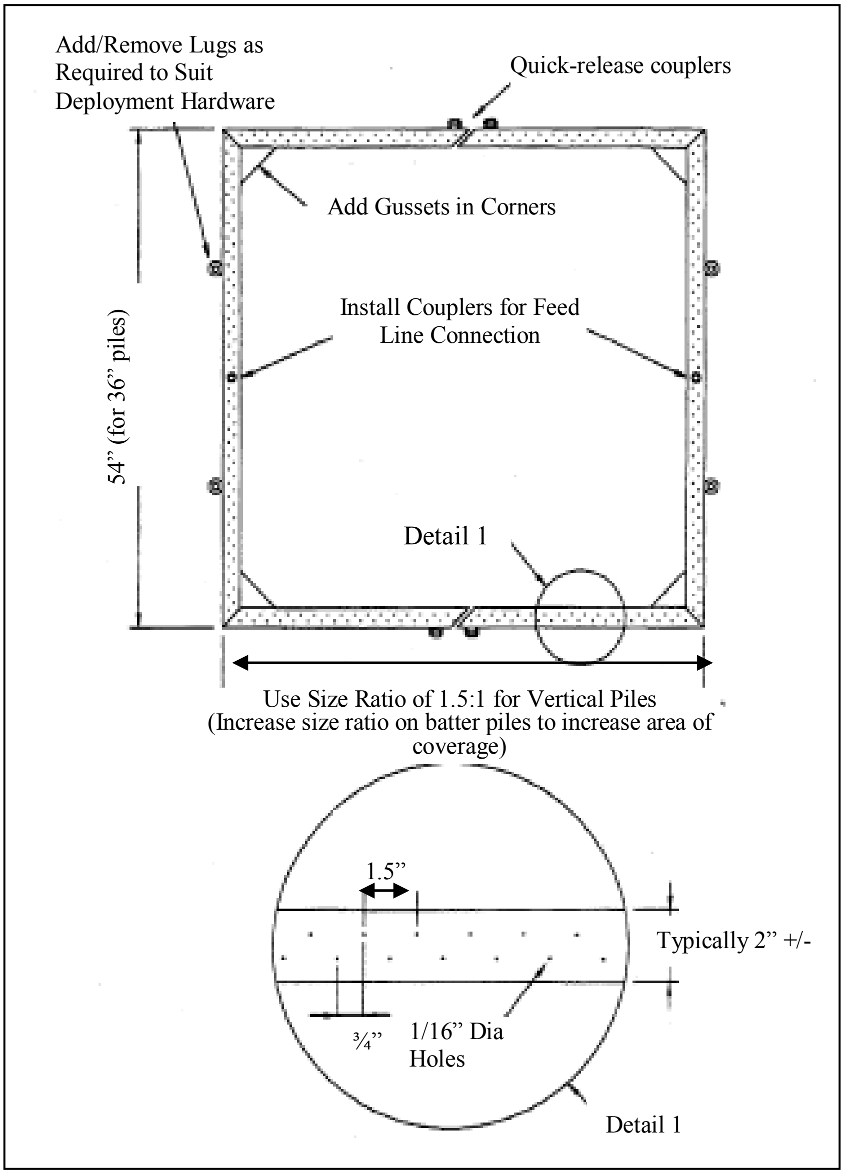

Figure 7-8. Air manifold design.
Source: Longmuir et al. (2001).

WSDOT conducted a test pile project for the Vashon Ferry Terminal (Laughlin, 2010a) where the University of Washington Applied Physics Lab and Department of Mechanical Engineering tested a Temporary Noise Attenuation Pile (TNAP) which consisted of an inner and outer steel casing with an inner air chamber between the casings that was partially filled with foam. At the bottom on the inside of the inner casing was a bubble ring. Sound reduction achieved ranged between 8 and14 dB with an overall average of 11 dB. Most of the reduction in noise energy occurred at frequencies above approximately 800 Hz.

Fabric barriers have also been used to attenuate SPLs from pile driving activities. The theory is somewhat the same as for an air bubble curtain, in that the goal is to change the local impedance of the water that noise must travel through. Cofferdams can be used as well, and may be applied either full of water or drained to the mudline. Cofferdams full of water provide only limited attenuation, while dewatered cofferdams may provide the best isolation of the driven pile.[27]

Because of the large variability in the effectiveness of bubble curtains (and fabric barriers), there is no standard rate of attenuation assumed. Projects may either state their expectation of bubble curtain performance for use in the analysis, or a rate of effectiveness may be determined through the consultation itself. If the BA states an expected performance level (thereby making that level part of the project description), the author should consider that in Washington State average reductions in SPLs are approximately 11 dB for an unconfined bubble curtain, 13 dB for a confined bubble curtain and 12 dB for a TNAP (Laughlin 2010c[28]).

Tables 7-10 through 7-12 show the noise reductions achieved for various projects, pile diameters, substrate types and hammer energy ratings since 2005 for WSDOT projects.

7.2.4 Determining the Extent of Underwater Project-Related Noise

The action area for a project is defined as the extent of the physical, chemical, and biological effects of the action. When considering the extent of the noise element of the action area (i.e., extent of project-related noise), consider the underwater area through which noise will travel until it reaches ambient levels.

7.2.4.1 Steps for Defining the Extent of Project-Related Noise

The following subsection provides instruction for determining the extent of project-related underwater noise to help define the action area; noting that noise is just one element of the project that must be considered when defining the action area.

A brief example of how one would use the concepts discussed above to define the extent of project-related underwater noise is provided here.

- Assume that a typical unattenuated peak noise level produced by driving a steel pile with a diesel hammer is 195 dB_{RMS} at a distance of 10 meters (33 feet) from the pile. Also assume a log (R) coefficient of 4.5 dB per doubling of distance (practical spreading model).

- Calculations used by the Services for determining at what point the project noise becomes indistinguishable from ambient sound assume a 4.5 dB decrease with each doubling of distance. At this rate of loss, the noise level from the source described above declines to 135 dB_{RMS} at

[27]. Thorson, P. and J.A. Reyff. 2004. Marine mammal and acoustic monitoring for the eastbound structure. San Fransisco – Oakland Bay Bridge East Span Seismic Safety Project. Report submitted for Incidental Harassment Authorization issued November 14, 2003, to Caltrans.

[28] Laughlin, Jim. 2010c. Average Noise Reductions Using Different Minimization Strategies for WSDOT Impact Pile Driving Operations. WSDOT – Technical Memorandum.

Table 7-10. Average noise reduction values for all Washington State DOE projects from 2005 to 2009 for steel piles of different diameters using an unconfined bubble curtain.

Location	Pile Diameter (inches)	Substrate Type	Hammer Energy Rating (ft-lbs) [a]	Date	Pile #	Average Noise Reduction per Pile (dB)
Friday Harbor Ferry Terminal	24	Silty sand with hard clay layer	60,000	2/10/05	1	5
				2/23/05	4	0
				2/24/05	5	1
	30	Silty sand with hard clay layer	60,000	3/4/05	8	3
					Project Average:	2
Bainbridge Island Ferry Terminal	24	Sand and Fist-sized rocks to 1-foot rocks	55,000	10/18/05	1	14
					2	10
				10/20/05	3	7
					4	3
					5	3
					Project Average:	7
Cape Disappointment Boat Launch Facility [b]	12	Silt and mud with glacial till layer	52,000	12/13/05	1	6
				12/14/05	2	14
					3	11
					4	17
					5	6
					Project Average:	11
Mukilteo Test Pile Project	36	Sand and silt	164,000	11/16/06	R2	7
					T2	22
					Project Average:	15
Anacortes Ferry Terminal	36	Sand and Silt Mix	165,000	1/17/07	1	11
					2	11
				1/19/07	4	5
					5	10
					6	8
					7	3
					8	9
					Project Average:	8
SR 520 Test Pile Project	24	Very loose unconsolidated silt overlying glacial till	20,100	10/27/09	PB-1	11
					PB-2	3
					PB-3	26
					PB-4	28
	30			10/29/09	WAB2	32
					WAB5	19
					Project Average:	20

Table 7-10 (continued). Average noise reduction values for all Washington State DOE projects from 2005 to 2009 for steel piles of different diameters using an unconfined bubble curtain.

Location	Pile Diameter (inches)	Substrate Type	Hammer Energy Rating (ft-lbs) [1]	Date	Pile #	Average Noise Reduction per Pile (dB)
SR 529 Ebey Slough Bridge Replacement Project	72	Deep loamy silt	327,222	1/6/11	4	16
					5	22
				1/11/11	3	24
					6	26
					Project Average:	22
Overall Average:						12

[a] Actual energy used during operation of impact hammer is approximately 50% to 70% of this maximum energy for most piles. All hammers are diesel.

[b] These piles had steel wings that linked the piles together and pile caps were used between the pile and the hammer which possibly increased the number of total strikes per pile.

Table 7-11. Average noise reduction values for all Washington State DOT projects from 2005 to 2009 for steel piles of different diameters using a confined bubble curtain.

Location	Pile Diameter (inches)	Substrate Type	Hammer Energy Rating (ft-lbs)	Date	Pile #	Average Noise Reduction per Pile (dB)
SR 24 – Yakima River	24	Large 1-to 3-foot diameter boulders (riprap) with river rock and gravel below	60,000	6/7/05	3	0
				6/14/05	5	5
					Project Average:	3
Eagle Harbor Maintenance Facility	24	unknown	164,000	10/31/05	1	7
					3	4
					Project Average:	6
SR 411 Cowlitz River	24	Silty Sand	72,900	7 – 8/ 2006	4	8
					7	4
					8	9
					Project Average:	7
SR 520 Test Pile Project	30	Very loose unconsolidated silt overlying glacial till	20,100	10/29/09	WAB1	38
					WAB4	34
					Project Average:	36
Overall Average:						13

[a] Actual energy used during operation of impact hammer is approximately 50% to 70% of this maximum energy for most piles. All hammers are diesel.

Table 7-12. Average noise reduction values for all Washington State DOT projects from 2006 to 2009 for steel piles of different diameters using a Temporary or Double Walled Noise Attenuation Pile (TNAP or DNAP).

Location	Pile Diameter (inches)	Substrate Type	Hammer Energy Rating (ft-lbs) [a]	Date	Pile #	Average Noise Reduction per Pile (dB)
Mukilteo Test Pile Project (TNAP1) [b]	36	Sand and silt	164,000	11/16/06	R4	7
				2/19/07		15
Mukilteo Test Pile Project (TNAP2) [c]	36	Sand and silt	164,000	11/16/06	R3	21
					R1	17
					Project Average:	15
SR 520 Test Pile Project (DNAP) [d]	30	Very loose unconsolidated silt overlying glacial till	20,100	10/29/09	WAB3	11
					Project Average:	11
Vashon Test Pile Project (modified TNAP) [e]	30	Silty Sand	164,620	11/17/09	P-14	9
					P-10	9
				11/18/09	P-16	13
					P-8	12
					Project Average:	11
					Overall Average:	12

[a] Actual energy used during operation of hammer is approximately 50% to 70% of this maximum energy for most piles. All hammers are diesel.

[b] TNAP1 (Temporary Noise Attenuation Pile) is a hollow walled steel pile casing placed around the pile being driven. Hollow cavity accidentally filled with water during installation, thus substantially reducing its potential effectiveness. The TNAP1 was repaired and retested on 2/19/07.

[c] TNAP2 is a steel pile with a 2-inch thick closed cell foam lining on the inside of the pile and a perforated metal screen on the inside of the foam.

[d] DNAP is a steel casing with a 1-inch air space and 4 inches of insulation and an inner steel casing sealed together at the top and bottom.

[e] Modified TNAP is a hollow steel casing with a 2-inch foam-filled hollow wall and a bubble ring on the inside at the bottom but only sealed at the bottom.

100,000 meters (62 miles). $R_1 = R_2 * 10^{((195-135)/15)}$. However, in both river systems and in Puget Sound, land masses are usually encountered well before this distance is reached, effectively reducing the extent of the action area. As mentioned above, temperature gradients, bottom topography, and currents can cause noise levels to attenuate more quickly. Therefore, it is often difficult to accurately determine the extent of noise using a standard geometric spreading model.

- In addition, the use of a bubble curtain can reduce the levels at the source. Assuming a 5 dB reduction at the source described above from use of an air bubble curtain, the distance at which the noise reaches an ambient level (135 dB_{RMS}) in marine waters is reduced to 46,416 meters, a 54 percent reduction of the noise extent.

The following example will use the Practical Spreading Loss model in use by the Services to illustrate the procedure for determining the extent of project-related noise.

1. **Estimate the equipment noise level for the project**. Though there are many types of equipment potentially used during underwater construction, pile driving is one of the most common activities in underwater construction. To determine the noise levels associated with pile driving determine the hammer type as well as the pile type being used. Peak decibels associated with different types of piles are listed in Table 7-9 above.

    - ***Example** – Driving a 30-inch steel pile will produce a 196 dB_{RMS} noise level estimated at 10 meters from the pile.*

2. **Estimate the baseline sound level**. Determine if there have been any noise studies in the vicinity of your project that may be able to specifically define baseline underwater sound levels. If not, based on some of the information cited above, you could estimate a reasonable baseline sound level.

    - ***Example** – The project takes place in Puget Sound and no noise studies have been completed in the vicinity of the project. However, based on the ambient sound discussion above, and considering the project is located near a busy port, a baseline noise level of 135 dB_{RMS} is assumed.*

3. **Determine applicable noise reduction factors**. Identify if there are any noise reduction factors that are present either as a result of the physical location of the project (shallow water, confined harbor, soft-bottom substrates, structures, currents, etc.) or impact minimization measures that will be implemented during construction.

- ***Example –*** *The project site is bordered on the east by shoreline and upland habitats. As a result, underwater noise associated with pile-driving activities will dissipate 100 to 200 meters to the east of the locations where piles will be installed. To the west shorelines are located 5 miles away. The northern end of the harbor is located 2 miles away and the southern end of the harbor is located 2 miles away from the project site. A bubble curtain will not be used.*

4. **Use the Practical Spreading loss model to determine the extent of project-related underwater noise.**

- ***Example –*** $TL = 15Log(R_1/R_2)$***, or solved for*** R_1, $R_1 = (10^{(TL/15)})(R_2)$. *$R_1$ is the distance where noise attenuates to ambient levels, R_2 is the range of the known noise level, and TL is the amount of spreading loss (known noise level – ambient sound level).* $(10^{(196-135/15)})(10) = 116{,}591$ *meters. Therefore, according to the Practical Spreading Loss model, noise would not attenuate to ambient levels in open water for approximately 72 miles. This is likely an invalid distance, and true attenuation to ambient levels likely happens somewhere prior to the modeled distance. The project biologist should determine where an appropriate extent is located, based on land masses, marine objects, and variances in ambient conditions throughout the environment. For example, a busy shipping lane located near the area may limit the extent of noise.*

- ***Figure 7-9 maps the extent of the example project.*** *Noise pressure travels in a linear direction (concentrically) away from the source; when the noise intersects a landmass, it is assumed to not travel through the land mass or to reflect off of the land mass. Any protruding land mass within the aquatic area, in this case the mouth of the harbor, will likely create a "shadowing effect". The actual extent of project-related noise defined by the Practical Spreading Loss model would actually be much further out than shown in the example. The opposite shoreline defines the extent.*

7.2.4.2 Species and Noise

As is stated in the first section of this chapter, one task the project biologist must complete is identifying and measuring noise to determine the noise element of the action area. Another task the project biologist must complete is analyzing the effects of noise on the species that are addressed in the BA.

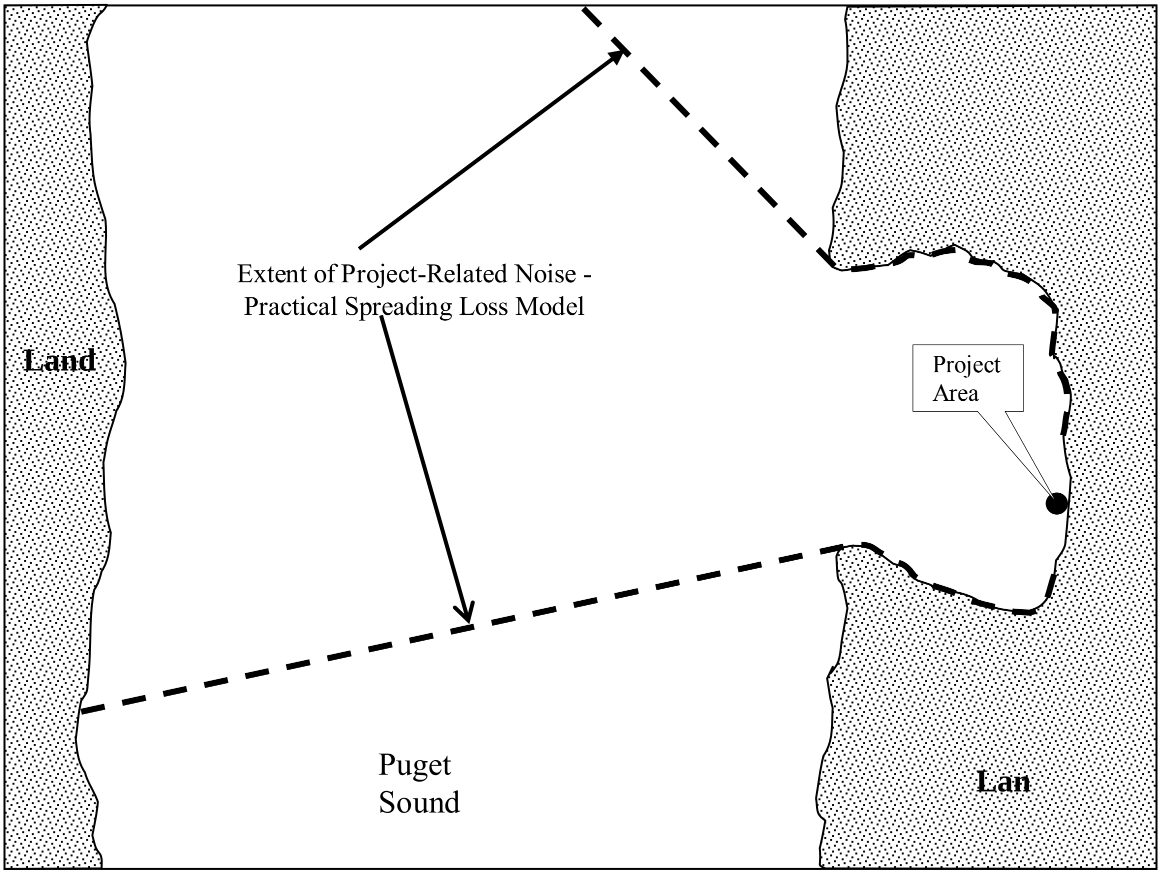

Figure 7-9. Example showing extent of project-related noise.

7.2.4.3 How Aquatic Species Hear

Fish – Hearing

The main sensory organ in fish is the lateral-line system that detects low-frequency (<100 Hz) particle motion in water. The lateral-line organ is likely involved in acoustic repulsion when the source is within a few body lengths of the fish. The inner ear located within the skull of the fish is sensitive to vibration rather than noise pressure.[29] In fish species that are hearing specialists, the gas-filled swim bladder acts as a transducer that converts noise pressure waves to vibrations, allowing the fish to detect noise and vibration.

Fish species with no swim bladder or a small one tend to have a relatively low auditory sensitivity. Fish having a fully functional swim bladder tend to be more sensitive. Fish with a close coupling between the swim bladder and the inner ear are most sensitive.

[29]. Fish have three symmetrically paired structures in the inner ear associated with bony otoliths: the lagena, sacculus, and utriculus. In most species, the saccule and lagena detect acoustic pressure and acoustic particle motion (Popper and Fay 1973) and the utricle is involved in sound detection by several species of clupeids and perhaps other species (Popper and Fay 1993).

Most audiograms of fishes indicate a low threshold (higher sensitivity) to noises within the 100 Hz to 2 kHz range (Stocker 2002) (Figure 7-12).[30] Anderson (1992) suggests that juvenile fish may have less developed hearing abilities so the distance at which they could detect pile driving noises might be much less than adults. Audiograms developed for various fish species are based on noise pressure. However, fish do not hear with noise pressure. They hear with particle motion. Therefore, the thresholds and frequency ranges listed above and in Figure 7-10 will likely be revised when those data are available.

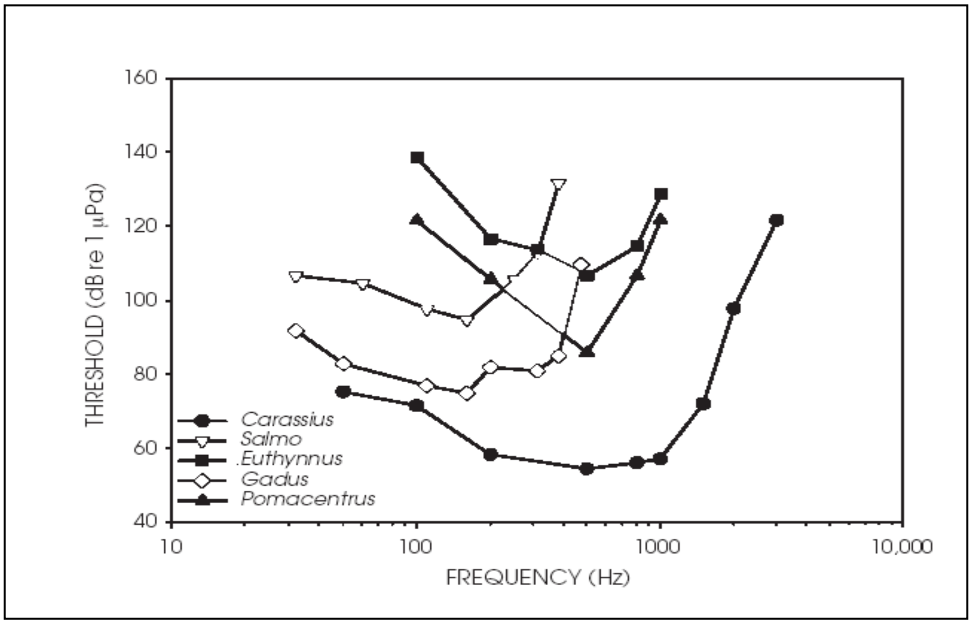

Figure 7-10. Audiogram for several fish species.
Source: Burgess and Blackwell (2003).

High-intensity noises may temporarily or permanently damage the hearing of fish.[31] Temporary hearing damage is referred to as a temporary threshold shift and permanent hearing damage is referred to as a permanent threshold shift. However, damage to hearing by intense noise depends on auditory thresholds and will thus vary from species to species (Popper and Fay 1973, 1993).[32]

30. Cod have a hearing threshold of 75-80 dBrms between 100 and 200 Hz (Chapman and Hawkins 1973). Atlantic salmon have a sensitivity of 95 to 100 dBrms between 100 and 200 Hz (Hawkins and Johnstone 1978). Since both species are most sensitive between 100 and 200 Hz one would expect to see damage to salmon occurring with exposure to continuous sound at about 200 dBrms (Hastings 2002).

31. Popper and Clarke (1976) found that goldfish (*Carassius auratus*) demonstrated up to a 30 dB decrease in hearing sensitivity when exposed to 149 dB for 4 hours, but hearing returned to normal after 24 hours. Enger (1981) used a sound level of 180 dB to destroy bundles of cilia on the saccular maculae of codfish as evidenced by scanning electron microscopy and assumed permanent hearing loss.

32. Enger (1981) exposed 26 cod (*Gadus morhua*) to continuous tones of 180 dBrms at frequencies from 50 to 400 Hz for 1 to 5 hours and found destruction of auditory cilia cells in the saccule. Hastings (1995) found destruction of auditory sensory cells when she and her colleagues exposed goldfish (*Carassius auratus*) to continuous tones of 189, 192, and 204 dBpeak at 250 Hz and found destruction of ciliary bundles correlate with sound pressure level at a 95% confidence level. Hastings et al. (1996) found destruction of sensory cells in the inner ears of Oscars (*Astronotus ocellatus*) four days after being exposed to continuous sound for 1 hour at 180 dBpeak and 300 Hz. Fish exposed to

Popper et al. (2005) exposed three species of fish to noises from a seismic airgun, having noises similar to pile driving. Peak noise levels ranged between 205 and 209 dB. They exposed a hearing generalist (broad whitefish), a hearing specialist (lake chub), and a species that is intermediate in hearing (northern pike). They found that the hearing generalist had no significant effects from air gun exposure; the lake chub indicated the most effect in temporary threshold shift, and the northern pike showed a significant hearing loss but less than that of the lake chub. Lake chub and northern pike returned to their respective normal thresholds after 18 to 24 hours.

One study completed by Feist et al. is particularly pertinent to species potentially occurring in Washington. Feist et al. (1992) looked at the effects of concrete pile driving activities on the behavior and distribution of juvenile pink and chum salmon in Puget Sound. The authors found that juvenile pink and chum salmon (1 to 2 inches total length) did not change their distance from shore or cease feeding in response to pile driving. However, they did find that there were substantial differences in the distributions and sizes of fish schools on pile-driving days versus non-pile-driving days.

Fish: Lethal Impacts Associated with Noise

Risk of injury or mortality for aquatic species and fish associated with noise, in general, is related to the effects of rapid pressure changes, especially on gas filled spaces in the body. Rapid volume changes of the swim bladder may cause it to tear, reducing hearing sensitivity in some hearing specialist species, and loss of hydrostatic control.

According to Hardyniec and Skeen (2005)[33] and Hastings and Popper (2005) the effects of underwater noises created by pile driving on fish may range from a brief acoustic annoyance to instantaneous lethal injury depending on many factors including:

- Size and force of the hammer
- Distance of the fish from the pile
- Depth of the water around the pile
- Depth of the fish in the water column
- Amount of air in the water

180 dBpeak sounds at 60 Hz either continuous or 20% duty cycle (impulsive) or to 180 dBpeak sounds at 300 Hz and 20% duty cycle for 1 hour had no apparent damage. The authors also found no damage in fish allowed to survive for only 1 day after exposure, suggesting that damage may develop slowly.

Hastings et al. (1996) also examined the sensory cells of the lateral line and semicircular canals of the inner ear in the Oscars and found no damage. The authors speculated that this could be related to the fact that these sensory cilia cells do not have an overlying otolith.

McCauley et al. (2003) exposed caged pink snapper (*Pagrus auratus*) to air gun sound levels as the ship passed by the caged fish, producing damaged cilia cells that did not regenerate up to 58 days after exposure.

33. Hardyniec, Sara and Sarah Skeen. 2005. Pile driving and barotraumas effects. J. Transportation Research Board, No. 1941, pp. 184 – 190.

- The texture of the surface of the water (amount of waves on the water surface)
- The bottom substrate composition and texture
- Size of the fish
- Species of the fish
- Physical condition of the fish

Physostomus fishes, such as salmonids, regulate the air in their swim bladders through a direct connection to the esophagus. Salmonids acclimate their swim bladders by gulping air at the surface, and as they swim deeper the swim bladder becomes compressed. When exposed to a sudden positive pressure, or overpressure, the swim bladder compresses further. When exposed to a sudden negative pressure, or underpressure, the swim bladder may expand beyond its original volume at depth but may not suffer or injure any other organs because it has some room to expand. Physostomus fishes acclimated to the surface atmospheric pressure may suffer less injury or mortality the deeper they are in the water column, whereas those acclimated to deeper water pressure may suffer more injury near the surface or in shallow areas (Carlson 2003 personal communication).

Physoclistus fishes, such as bluegill, regulate air in the swim bladder through the circulatory system. In a physoclistus fish, the swim bladder will roughly maintain its volume at depth. During exposure to underpressure, the swim bladder will expand, possibly tearing and causing damage to other organs. The magnitude of the expansion of the swim bladder is dependent on the magnitude of the underpressure. It functions according to Boyle's law: The volume of a confined amount of gas at constant temperature is inversely proportional to the pressure applied to the gas (Carlson 2003 personal communication).

There have been a few studies addressing the effects of pile driving on fish, which are described here, and others are summarized in the footnotes.[34] Illingworth and Rodkin (2001) found that there was not only a relationship between distance from the pile but an increase in the degree of

[34]. Diver observations made by the Port of Vancouver (PoV) in Canada following pile driving 36-inch steel piles into sandstone bedrock found higher mortality rates on the bottom than observed on the surface although no counts were reported (DesJardin 2003 personal communication). Fish mortalities at the PoV included herring, juvenile salmon, rockfish, and tomcod.

Experiments conducted by the Pacific Northwest National Laboratory (PNNL) placed bluegill in a hyperbaric chamber and acclimated one group to simulated ambient surface pressures of 101 kilopascals (kPa) and another group to simulating ambient pressures at 30 foot depth of 191 kPa inside a hyperbaric chamber. The fish were then exposed to 400 kPa for 30 to 60 seconds followed by rapidly decreased pressure to 2 and 10 kPa respectively within 0.1 seconds. The fish were then held for 48 hours for observation (Carlson 2003 personal communication). The results for bluegill indicated 90% injury and 21% mortality to the 30 foot acclimated group and 35% injury and 5% mortality to the surface acclimated group (after 48 hours). Carlson (2003 personal communication) found that both acclimation (Pa) and exposure (Pe) pressures are important and the ratio of Pe to Pa is an important predictor to mortality and possible injury. Similar unpublished work has been done with rainbow trout and results indicated no mortality and minimal injury.

damage and number of fish impacted with increasing duration of exposure to pile-driving activities.[35] Illingworth and Rodkin (2001) found that both a smaller hammer size and bubble curtains reduced injuries to fish.[36] In the literature review by Hastings and Popper (2005) they found that the study by Yelverton (1975) using underwater explosives indicated that smaller fish were more likely to be harmed than larger fish during underwater explosions.

Fish: Behavioral Impacts Associated with Noise

Mueler et al. (1998)[37] and Knudsen et al. (1992; 1996)[38] found that juvenile salmonids (40 to 60 mm length) exhibit a startle response followed by a habituation to low frequency (infrasound) in the 7 to 14 Hz range. Mueler et al. (1998) and Knudsen et al. (1992, 1996) also indicate that noise intensity level must be 70 to 80 dB above the hearing threshold at 150 Hz to obtain a behavior response.

According to Feist et al. (1992) broad-band pulsed noise (e.g., pile driving noise) rather than continuous, pure tone noises are more effective at altering fish behavior. However, the noise level must be at least within the minimum audible field of the fish for the frequencies of interest (1 to 100 Hz for pile driving). Ambient sound should be at least 24 dB less than the minimum audible field of the fish, and the pile driving noise levels had to be 20 to 30 dB higher than ambient sound levels in order to produce a behavioral response (in herring) (Olsen 1969, 1971).

Behavioral sensitivity is lowest in flatfishes that have no swim bladder and also in salmonids (brown trout) in which the swim bladder is present but somewhat remote from the inner ear. Gadoid fishes (cod, whiting) in which the swim bladder is closely associated with the inner ear display a relatively high sensitivity to noise pressure (Turnpenny et al. 1994).

Hastings and Popper (2005) present a summary of different noise levels and effects on fish based on a review of the best available science from the literature that has the most relevance to pile driving. However, the review does not include Pacific Salmon species or bull trout, the species project biologists would need to address in their BAs.

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[35]. In one experiment, all fish exposed to pile driving for one minute were unaffected while 80 percent of fish exposed for 6 minutes exhibited significant tissue damage. In a second experiment, only fish exposed for 40 minutes or longer were seriously injured.

[36]. The authors put fish in cages at various distances from 8-foot diameter steel piles, and 60% of fish were found with damage to their internal organs as far as 150 meters (492 feet) from the pile driven by the large hydraulic hammer (1,700 kJ maximum) and no bubble curtain. With a smaller hydraulic hammer (750 kJ maximum) and a bubble curtain in operation, only 40% were damaged at this distance. In general, the greatest impacts were observed within a 30-meter (98-foot) radius of the pile. It is assumed that there would be a decrease of 3 dB with halving of the hammer energy.

[37]. Mueller, R. P., D. A. Neitzel, W.V. Mavros, and T. J. Carlson. 1998. Evaluation of low and high frequency sound for enhancing fish screening facilities to protect outmigrating salmonids. U.S. Dept. of Energy, Portland, Oregon. Project number 86-118.

[38]. Knudsen F.R., P.S. Enger, and O. Sand. 1992. "Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar L.*" *Journal of Fish Biology* 40:523-534.

Knudsen F.R., C. Schreck, and S. Knapp. 1996. "Avoidance responses and habituation to low frequency sound in juvenile steelhead and Chinook." (Submitted for publication.)

Jorgensen (unpublished) from Fisheries and Oceans Canada recently presented preliminary data suggesting that that noise generated by an air gun at noise levels between 205 and 209 dB_{peak} indicated no significant difference in startle response in the vertical direction or vertical velocity and a possible slight difference in the horizontal direction. The author also indicated that observed fish did not actively avoid the noise, and there appeared to be no hearing loss. The fishes studied included broad whitefish, northern pike, and lake chub.

Hearing – Marine Mammals

Different taxa of marine mammals are sensitive to different frequencies of sound. For small toothed whales (Odontocetes), such as killer whale, and pinnipeds (seal and sea lion) studies of hearing have generally been conducted on a few individuals of some species. Therefore, individual variation within a species may not be represented in the results. No studies of baleen whales (Mystecetes sp.) have been conducted.

Killer whale have an estimated auditory bandwidth of 1 kHz to 100 kHz and are most sensitive around 20 kHz (Szymanski et al. 1999, as cited in 76 FR 4300). In a review by Au and Hastings (2008)[39] the audiogram shape, level of maximum sensitivity, and high-frequency limits of the killer whale were similar to other small odontocetes tested.

Humpback whales, like all baleen whales, are low-frequency cetaceans. Because, no direct measurements of auditory capacity have been conducted for these large whales, hearing sensitivity for low-frequency whales has been estimated by Southall et al. (2007) [40] from various studies or observations. A generalized estimate of an auditory bandwidth of 7 Hz to 22 kHz for all baleen whales is cited in Southall et al. (2007) from Ketten et al. 2007.

Pinnipeds communicate both on land and underwater. Both in-air and in-water pinniped audiograms are similar to typical mammalian audiograms; there is a low-frequency region that increases in sensitivity with frequency, a high-sensitivity dip at mid frequencies, and a high-frequency region in which sensitivity decreases rapidly with frequency (Au and Hastings 2008). Underwater hearing studies have been conducted on several species of pinnipeds but not on Steller sea lions. Studies conducted on California sea lions (in the same family as Steller sea lions, Otariidae) found the range of maximal hearing sensitivity is between 1 and 28 kHz, functional high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz (Schusterman et al. 1972, as cited in 76 FR 4300). At lower frequencies (below 1 kHz) sounds must be louder in order to be heard (Au and Hastings 2008; Kastak and Schusterman 1998, as cited in 73 FR 41318). As previously stated, studies of hearing have generally been conducted on a few individuals. Therefore, individual variation within a species may not be represented in the results.

[39] Au, W.W. and M.C. Hastings. 2008. Principles of Marine Bioacoustics. Spring Science, LCC.

[40] Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Green Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquat. Mamm. 33:414-521.

Southall et al. (2007) designated a functional hearing group for pinnipeds and estimated the lower and upper frequencies of the groups. The functional hearing group designated for all pinnipeds is 75 Hz and 75 kHz for underwater hearing (with the greatest sensitivity between approximately 700 Hz and 20 kHz) and between 75 Hz and 30 kHz for aerial hearing. Studies indicate that pinnipeds are sensitive to a broader range of sound frequencies in water than in air (Southall et al. 2007).

Marine Mammals: Impacts Associated with Noise

Marine mammals produce sounds in various contexts and use sound for various biological functions including social interactions, foraging, orientation, and predator detection. Interference with producing or receiving sounds could have negative consequences including impaired foraging efficiency from masking, altered movement of prey, increased energetic expenditures, and temporary or permanent hearing threshold shifts due to chronic stress from noise (Southall et al. 2007).

Marine mammals, like other mammals, can experience a masking effect from noise exposure. Masking occurs when environmental noise is loud enough to cover or mask other noises. However, unlike other mammals and pinnipeds, toothed whales echolocate and communicate by ultrasonic pulsed calls, whistles, and clicks. Their highly developed acoustic ability is used for navigation, prey location, and communication. Noise can mask echolocation and impede communication necessary for cooperative foraging (Bain and Dahlheim 1994) [41]. Masking decreases the area where prey items are detectable by echolocation. Masking is most acute when the noise source is directly in front of killer whales (Bain and Dahlheim 1994).

Exposure to chronic or high levels of sound may result in physiologic effects to hearing or, in extreme cases tissue damage or stranding. Temporary threshold shift (TTS) occurs when the auditory system is exposed to a high sound level over a duration that causes the cochlear cilia cells to fatigue and results in an a temporary decrease in hearing sensitivity. The hearing sensitivity returns when the cilia cells return to their normal shape (Au and Hastings 2008). Permanent threshold shift (PTS) is the term used when hearing sensitivity is permanently altered from high levels of sound exposure due to damage of the cochlear cilia cells. High levels of sound exposure may result in hemorrhaging around the brain and ear bones (NMFS 2005[42]). Other results from intense acoustic exposure, such as naval sonar, may lead to stranding of cetaceans, either from behavioral reactions or injury.

A sound source's frequency compared to a species hearing frequency range, as well as the intensity and energy from the source that are received by an animal, affect the potential for sound

41 Bain, D.E., R. Williams, J.C. Smith, and D. Lusseau. 2006. Effects of vessels on behavior of Southern Resident killer whales (*Orcinus spp.*) 2003-2005. NMFS Contract AB133F05SE3965. Available from D.E. Bain, Friday Harbor Laboratories, University of Washington, 630 University Road, Friday Harbor, WA 98250.

42 NMFS. 2005. Assessment of acoustic exposures on marine mammals in conjunction with USS Shoup active sonar transmissions in the eastern Strait of Juan de Fuca and Haro Strait, Washington. 5, May 2003. NMFS Office of Protected Resources, Silver Spring, MD.

to cause masking, a behavioral response, or physical injury. In addition, Southall et al. (2007) noted, that even in well controlled studies, behavioral responses in marine mammals and conditions which elicit the response are highly variable and strongly dependent upon the context of exposure and by an individual subject's prior experience, motivation, and conditioning.

7.2.4.4 Threshold Levels

In 2002, Hastings recommended 180 dB_{peak} for injury and 150 dB_{RMS} for behavior effects as the thresholds for protecting salmon.[43] These recommendations have been used by the Services in numerous biological opinions. Popper et al. (2006)[44] developed a more conservative interim criteria which proposes the use of both 187 dB SEL and 208 dB_{peak} as protective thresholds of injury to fish (this does not address potential harassment, so does not replace the 150 dB_{RMS} threshold for behavioral effects). The SEL is based on a single strike rather than on cumulative strikes. In January of 2008 Hastings and Popper proposed refining these injury thresholds to 189 dB SEL and 206 dB_{peak}. Based on recommendations of the Fisheries Hydroacoustic Work Group, in June of 2008, FHWA, WSDOT, the Oregon Department of Transportation, California Department of Transportation, Regions 1 and 8 of the USFWS, and the Northwest and Southwest Regions of NMFS reached agreement on the interim fish noise exposure thresholds.

The current interim thresholds for fish are as follows:

- 206 dB_{peak}
- 187 dB cumulative SEL for fish $\geq$ 2 grams
- 183 dB cumulative SEL for fish < 2 grams

Where cumulative SEL (SEL(cum)) is calculated as:

SEL(cum) = SEL(single strike at ~10 meters from the pile) + 10 * log (# strikes).

The number of strikes is estimated based on how many strikes occur in a summation period. Typically, the summation period is a day and includes a break in pile driving for 12 to 18 hours. The break between summation periods allows fish to move out of the affected areas or time to recover from temporary threshold shifts. If the cumulative SEL threshold is exceeded in a summation period, physical injury to fish is possible. Whether or not physical injury occurs is dependent on the project, and site-specific factors, such as local habitat conditions, as well as species specific factors. One factor to consider is whether the fish being analyzed are stationary or are migrating through an area.

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[43]. These recommendations were based on long-term exposure to a pure tone.

[44]. Popper, Arthur N., Thomas J. Carlson, Brandon L. Southall, and Roger L. Gentry. 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper.

The 150 dB_{RMS} threshold for potential behavioral effects is still being applied; however, more research and discussions will be needed to get a better understanding of the behavioral component of the thresholds. It is impossible to mitigate pile driving noise levels below the 150 dB_{RMS} level at this time. Sound pressure levels in excess of 150 dB_{RMS} are expected to cause temporary behavioral changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. Depending on site specific conditions, project timing, project duration, species life history and other factors, exposure to these levels may cause behavioral changes that rise to the level of "take". Those levels are not expected to cause direct permanent injury, but may indirectly affect the individual (such as impairing predator detection). It is important to note that this is a "may affect" threshold, not an adverse affect threshold. Whether or not 150 dB_{RMS} causes take is dependent on consideration of numerous factors.

WSDOT has observed fish kills during some of its pile driving. Sound level measurements at the Mukilteo Test Pile Project (Laughlin, 2007) indicated that the estimated sound levels measured at the time of the fish kills were 209 dB_{peak}, 202 dB_{RMS}, and 183 dB SEL for a single strike. Many of the killed fish observed were pile perch.

The USFWS (2004) has also identified underwater threshold and guidance noise levels for foraging marbled murrelets. The injury threshold of 180 dB_{peak} and the disturbance guideline of 150 dB_{RMS} are currently being used by USFWS. It was assumed that murrelet hearing underwater is the same as above water. Whether or not *take* actually occurs at these levels is dependent on numerous factors as is mentioned above.

NMFS is currently developing comprehensive guidance on sound levels likely to cause injury and behavioral disturbance in the context of the ESA and Marine Mammal Protection Act (MMPA). Until formal guidance is available, NMFS uses conservative thresholds of received SPLs from broadband sounds that may cause injury or behavioral disturbance to marine mammals (http://www.nwr.noaa.gov/Marine-Mammals/MM-sound-thrshld.cfm).

Currently the injury threshold for impulse noises (such as impact pile driving) is identified as 180 dB_{RMS} for whales and 190 dB_{RMS} for pinnipeds. The underwater disturbance threshold for whales and pinnipeds is 160 dB_{RMS} for impulse noises and 120 dB_{RMS} for non-impulse, continuous noises (i.e., vibratory pile driving). NMFS has also defined in-air thresholds for disturbance for hauled-out pinnipeds. The thresholds are 90 dB_{RMS} (unweighted) for harbor seals and 100 dB_{RMS} (unweighted) re: 20 µPa for all other pinnipeds.

The equations and procedures described in Section 7.1.4.2 can be used to determine the extent of project related noise above the airborne disturbance threshold for sea lions. The next section presents how to determine the extent of pile installation noise over the underwater disturbance and injury thresholds for marine mammals.

7.2.4.5 Extent of Project-Related Noise and Effect Determinations

The threshold levels established above can be used to define the zone of potential impact for salmon, bull trout, marine mammals, and diving marbled murrelets. For example, the zone of impact for injury to these species would occur in the area where project-related noise has not yet attenuated below the injury threshold level. The zone of impact for behavioral disturbance would be the area where project-related noise has not yet attenuated to the disturbance threshold. These distances can be calculated by using the Practical Spreading Loss model above, substituting the threshold level for the ambient level to determine the transmission loss.

The following example uses the Practical Spreading Loss model to illustrate the procedure for determining the distance to peak, RMS, and SEL(cum) thresholds for fish, diving marbled murrelets, whales, and Steller sea lion.

1. **Estimate the peak, RMS, and single strike SEL levels for the project.** If site specific data for the location, pile size, and pile type are available, use them as an estimate of the expected source levels of pile driving noise for the project. If not, for impact pile driving, use Table 7-9, Pile Diameter and Noise Levels (also available at http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#Noise) to estimate the source level in decibels for peak and RMS SPLs and single strike SEL for various pile diameters and types. To assure the values are agreed to by the Services, they should be presented at a pre-BA meeting.

   - ***Example** – An impact hammer will install four 36-inch piles. No site specific data on pile driving noise is available. From Table 7-9, at 10 meters, peak noise levels are estimated at 214 dB, RMS levels at 201 dB, and an SEL (single strike) at 186 dB.*

2. **Estimate the number of strikes per summation period.** The summation period is the number of piles **struck** in a period of time until there is a 12- to 18-hour period where no strikes occur. Typically this is per day. The Pile Strike Summary Table at http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#Noise provides data from previous projects on the number of pile strikes per day with hammer type energy ratings. The data in the tables can be used to calculate the cumulative SEL (SELcum). A link to the CalTrans Pile Driving Compendium is also provided for comparison.

   - ***Example** –Using data from the Pile Strike Summary Table, it was determined the conditions at the project site are most similar to the Anacortes ferry terminal. Therefore, the project is estimated to strike the four piles 2,494 times per day (total time for all four) for 1 day.*

3. **Estimate noise reduction from a bubble curtain or other noise attenuation device.** As stated previously, the use of a noise attenuation device can reduce the noise levels at the source. However, because of the large variability in the effectiveness of bubble curtains, the expected level

of attenuation from these or any other noise attenuation device should be discussed with the Services prior to submitting the BA in a pre-BA meeting.

- ***Example*** *– A bubble curtain will be used during impact pile driving. Based on past experience with this design of bubble curtain, a 10 dB reduction in noise levels is expected at 10 meters from the source.*

4. **Determine if the fish being evaluated in the area affected by pile driving are ≥2 grams or <2 grams.** NMFS is working on tables that list the month fish in each listed ESU reach 2 grams. This table is incomplete at this time, but may be posted at a later date on our website. Use site-specific ESU information for the area where the project is located, if available. Note that separate ESA and EFH analyses may be required. All marine and estuarine areas have fish less than 2 grams present at all times. The USFWS considers bull trout to be less than 2 grams in Washington where local populations occur in core areas (not in FMO) from December 15 to September 30 with the exception of the Puyallup core area, where bull trout may be less than 2 grams in local population areas from November 15 to August 30.

5. **Use the Practical Spreading Loss model to determine the extent of the distances to the thresholds for injury and potential disturbance effects for fish and marbled murrelets.** In order to determine the effectiveness of a noise attenuation device, some **hydroacoustic** measurements will be made without the device operating; therefore, estimates with and without the estimated reduction in SPL and SEL from a noise attenuation device must be calculated.

- ***Example*** ***– TL = 15Log(R₁/R₂), or solved for R₁, R₁ = (10^(TL/15))(R₂)***. *R_1 is the distance where noise attenuates to threshold levels, R_2 is the range of the known noise level, and TL is the amount of spreading loss (estimated noise level – threshold level). (Note: Calculators for TL are available at* http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#Noise. *See NMFS calculator and Marbled Murrelet SPL calculator.)*

- **Peak**

Estimated distance to the injury threshold for fish

$$10 * 10^{((214-206))/15)} = 34 \text{ meters}$$

(With noise attenuation) $10 * 10^{((204-206))/15)} = 7$ *meters*

Estimated distance to the injury threshold for marbled murrelets

$$10 * 10^{((214-180)/15)} = 1{,}848 \text{ meters}$$

(With noise attenuation) $10 * 10^{((204-180)/15)} = 398$ *meters*

- **RMS**

Estimated distance for potential behavioral effects for fish and murrelets

$$10 * 10^{((201-150)/15)} = 25{,}119 \text{ meters}$$

(With noise attenuation) $10 * 10^{((191-150)/15)} = 5{,}412$ *meters*

Estimated distance for potential behavioral effects for marine mammals

$$10 * 10^{((201-160)/15)} = 5{,}412 \text{ meters}$$

(With noise attenuation) $10 * 10^{((191-160)/15)} = 1{,}166$ *meters*

Estimated distance for potential harm for cetaceans

$$10 * 10^{((201-180)/15)} = 251 \text{ meters}$$

(With noise attenuation) $10 * 10^{((191-180)/15)} = 54$ *meters*

Estimated distance for potential harm for Steller sea lions

$$10 * 10^{((201-190)/15)} = 54 \text{ meters}$$

(With noise attenuation) $10 * 10^{((191-190)/15)} = 12$ *meters*

- **SEL(cum) (Determine if you have “stationary” fish or “mobile” fish.** Unless you are in a project location where you know listed fish will be moving through the injury and behavioral threshold areas, use the calculation for stationary fish. If you have “moving” fish and the Services agree, then use the NMFS calculator for moving fish. This calculator is only available from NMFS.

*SEL (cum) = SEL(single strike at ~ 10 meters) + 10 Log * (# strikes)*

$$186 + 10Log(2{,}494) = 220 \text{ dB}$$

(With noise attenuation) $176 * 10Log(2{,}494) = 210$ *dB*

Estimated distance to threshold for fish $\geq$2 grams

$$10 * 10^{(220-187)/15)} = 1{,}577 \text{ meters}$$

(With noise attenuation) $10 * 10^{((210-187))/15)} = 340$ *meters*

Estimated distance to threshold for fish <2 grams

$$10 * 10^{((220-183)/15)} = 2{,}512 \text{ meters}$$

(With noise attenuation) $10 * 10^{((210-183))/15)} = 541$ *meters*

- *Therefore, according to the Practical Spreading Loss model, in open water with no noise attenuation, impact pile driving noise would be expected to attenuate to the injury threshold for fish at 34 meters for peak levels, 1,577 meters for SEL(cum) levels for fish ≥2 grams, and 2,512 meters for fish <2 grams.* Therefore*, for this project with 2,494 pile strikes, the most conservative metric to estimate the distance to the injury threshold would be the SEL(cum). The distance to the injury threshold for marbled murrelet, cetaceans, and Steller sea lions is estimated to extend 1,848 meters, 251 meters, and 54 meters, respectively, in open water without the noise attenuation. In open water with no noise attenuation, pile driving noise would be expected to attenuate to the behavior threshold for fish and marbled murrelets at 25.1 kilometers and for marine mammals at 5.4 kilometers. These distances would be worst case and would only be expected to occur when the noise attenuation device was not in operation. Therefore, also include in the BA the expected distances to the thresholds with the expected reduction from the noise attenuation device.*

- ***Map the extent of the distance to each threshold.*** *As stated in the previous example, noise pressure travels in a linear direction (concentrically) away from the source; when the noise intersects a landmass, it is assumed to not travel through the land mass or reflect off of the land mass. Therefore, the project biologist should determine where the thresholds extend based on land masses.*

6. **For fish, estimate the area being affected.** For the area within a mapped circular threshold, the area is calculated simply as πR^2. For irregular shaped areas, Geographic Information System tools can be used.

7. **If possible, estimate how many fish are being affected.** If fish distribution data are available, use it to estimate the number of fish in the affected area.

As mentioned above, the disturbance threshold should be considered the "may affect" threshold. The project effect determination for fish, for example, is not automatically a "not likely to adversely affect" merely because the noise level is above the disturbance threshold but below the injury threshold. Other project conditions, such as timing, duration, or life history information may also be necessary to ensure the effects from noise are insignificant or discountable. Likewise, behavioral disruption could also result in a likely to adversely affect situation if measures cannot be taken to minimize effects.

Even if a species is outside the zone of behavioral disruption (i.e., located below 150 dB RMS for salmonids and marbled murrelet, or below 160 dB RMS for marine mammals), a *no effect* determination may not be warranted. For a *no effect* determination, the species must be located in a zone where all underwater noise has attenuated to baseline levels.

It is important to realize when using the threshold levels identified above that the injury and disturbance thresholds are measured in three different metrics, dB_{peak}, dB $SEL_{(cum)}$, and dB_{RMS}. When using the models, it is crucial to compare like values to ensure accuracy. For example, a noise level measured in peak should not be used to determine the distance of the disturbance threshold, which is measured in RMS. Likewise, using an RMS noise level to identify the injury threshold (peak) will lead to incorrect results.

7.2.4.6 Anticipated Project Requirements

The Services have completed recent consultations that have developed reasonable and prudent measures requiring underwater pile driving projects to mitigate for potential impacts. The bulleted statements below summarize what anticipated requirements may be for underwater pile driving projects:

- Vibratory hammers may be required where substrate conditions allow.
- Hydroacoustic monitoring will likely be required on any project with impact pile driving. A standard plan to conduct hydroacoustic monitoring is required for WSDOT projects. A template for the standard plan is available at <http://www.wsdot.wa.gov/Environment/Biology/BA/BAtemplates.htm>. The template should be filled in with project specific information and then included in the BA as an appendix. Check the webpage above for the most current version of the template.
- Visual marine mammal monitoring will likely be required for listed species that may be potentially present. For listed marine mammal species, such as the southern resident killer whale, humpback whale, or Steller sea lion, shut-down of impact or vibratory pile driving must occur for the area within the behavioral threshold, unless incidental take has been granted through both an ESA Section 7 consultation and an MMPA authorization. Shut-down of pile driving will always be required if any marine mammal (listed or not listed) approaches the injury zone.
- If the use of a bubble curtain or other attenuation method is not proposed, the Services may require the use of an attenuation method if SPLs or cumulative SELs exceed the threshold limits for a certain amount of time.

For example, pile driving without a bubble curtain may be allowed only if constant monitoring indicates the cumulative SEL levels do not exceed either the 183 dB or 187 dB cumulative SEL thresholds and peak levels never exceed 206 dB. If the cumulative SEL levels exceed either 183 dB or 187 dB, OR peak values exceed the 206 dB threshold, a bubble curtain will likely be required. However, these conditions are site and project specific.

- The design of any bubble curtain to be used will need to be reviewed in advance by the Services.

A hydroacoustic monitoring report should be submitted to the Services after pile driving is completed. Required report details are outlined in the standard Underwater Noise Monitoring Plan template available at <http://www.wsdot.wa.gov/Environment/Biology/BA/BAtemplates.htm>.

8.0 Action Area

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8.0 Action Area

Chapter Summary

- There is only one action area defined for a project.
- The action area is not determined by the extent of impacts on species and habitat; rather, it is determined by the geographical effects of the action on the environment.
- Each project has only one action area, not separate terrestrial and aquatic action areas.
- The action area should be defined in the Project Action Area section of the BA.
- A map or figure showing the action area should accompany the verbal description of the action area.
- Steps to be completed in order to define the action area are these:

  1. Identify all project impacts.
  2. Determine the geographic extent of each type of project impact in order to define a zone or area of project impacts for each.
  3. Overlay the multiple zones or areas of project impacts in combination to establish the geographic extent of all project impacts.
  4. Define the action area based upon the farthest geographic extent of potential project impacts.

- The action area may include discrete areas where project-related impacts may occur in isolation from the primary area of anticipated project impacts.
- Within the single action area, project biologists may choose to discuss some of the zones of impact previously defined, to facilitate report organization and analysis of effects.

This section provides guidance for defining the limits of the action area. BA excerpts are provided to illustrate how the project biologist can effectively define the limits of the action area.

8.1 Defining the Action Area

The general location of the project action area should be described in the BA. A map, legal description, and photographs (aerial or ground) can help to illustrate the context and extent of the project action area.

A project biologist's first task is to define the specific limits of the project action area. The limits of the action area should be based upon the geographic extent (in both aquatic and terrestrial environments) of the physical, chemical, and biological effects resulting from the proposed action, including direct and indirect effects, as well as effects of interrelated and interdependent activities.

The project biologist should provide clear justification of the action area limits so that BA reviewers can follow the author's line of thought and reasoning. The author should also provide reviewers with enough information to determine the accuracy of the limits defined.

> *Often, project biologists incorrectly identify the action area. The action area should be based on how far all effects of the action reach, not simply how far the impacts related to project equipment extend.*
>
> *For example, if an effect of an action (e.g., dewatering) can be detected 150 miles downstream of the project area, the entire 150 mile stretch of river would be included in the action area, as defined by the project.*

Defining the geographic extent of potential effects is often difficult. For example, delineating the limit of noise impacts, or determining how far noise will travel from a specific location before attenuating to background levels, can be speculative. For noise impacts in terrestrial areas, commonly accepted thresholds are often used (e.g., a 1-mile radius for pile driving activities). However these thresholds should be refined based upon an analysis of site-specific ambient noise levels and the predicted distance noise levels will travel before attenuating to ambient conditions. The geographic extent of project-related noise underwater can extend well beyond the radius defined for terrestrial impacts, depending upon surrounding bathymetry, water temperature, and other factors (see PART 2, NOISE IMPACT ASSESSMENT for more detailed information on analyzing noise impacts).

Estimating the maximum downstream distance through which sediment or pollutants can affect water quality also may be speculative. One approach uses the Ecology mixing zone distances that apply to many projects. Whatever the approach, a sound rationale—and, if possible, documented support for the limits—must be demonstrated.

Each project has just one action area, which is usually larger than the project site or footprint. The single action area for the project encompasses the extent of all direct and indirect effects related to the proposed action (as well as interdependent or interrelated activities) affecting both aquatic and terrestrial environments. In some situations it may be necessary to define a very large action area to address all project-related effects. The number of species addressed in a BA or occurring in the vicinity of a project plays no part in defining the action area for the project.

Action areas are three-dimensional, encompassing impacts above and below the water surface. Often the underwater portion of the action area has a size and shape different from the portion of the action area located above water.

To define the project action area, a project biologist should complete the following steps:

1. ***Identify all potential project effects***.
   This includes all direct and indirect effects, as well as those effects associated with interrelated and interdependent activities, occurring within both aquatic and terrestrial environments.

2. ***Determine zones of effect for each type of project effect***.
   Look at each type of project-related environmental effect (i.e., in-water sedimentation, terrestrial noise, underwater noise, clearing and grading, induced development, traffic, etc.) separately to determine its geographic extent.

3. ***Determine the geographic extent of all project effects***.
   Once the project biologist has identified zones representing the geographic extent of each type of project-related environmental effect, these zones can be combined to form a single representation of the geographic extent of all project effects.

4. ***Define the action area***.
   The action area is defined by the outermost extent of all of the zones of effect combined. The outer limits of the action area may be defined by the zone of effect identified for one type of project effect that extends farther than any other, or the limits of the action area may be defined by a combination of multiple zones of effect. In some instances there may be discrete areas affected by project activities that are not contiguous with the other zones of effect (for example, an offsite mitigation area). In these cases, the isolated area affected by project-related activities need not be physically lumped into the action area but can be considered a separate component of the action area.

8.1.1 Example of Process for Defining Action Area

This section provides two examples of how the action area for a project is defined. The first example shows how an action area is determined based upon the zones of impact defined for multiple project elements. The second example illustrates how an action area is defined in an aquatic environment, based upon anticipated noise impacts above and below the water.

The first example illustrates how the overall action area for a project is composed of the combination of multiple zones of effect that reflect potential impacts associated with each project element. In this example, the action area is defined based on the extent of project-related noise and the extent of project-related aquatic effects. The proposed project consists of roadway widening and replacement of a culvert. Figures 8-1a, 8-1b, and 8-1c show: 1) the overall action area, 2) the extent of project-related noise, and 3) the extent of project-related aquatic effects.

1. The first step in defining the action area is to identify all potential project effects. In this example, there is construction and pile driving noise associated with roadway widening and culvert replacement activities. The aquatic effects include potentially increasing downstream turbidity, and providing 1,600 feet of upstream fish passage to a creek segment that was previously impassable.

2. The second step is to define the zone or area affected by each type of anticipated project-related effect. These zones and the rationale for establishing their limits are described in the text within Figures 8-1b and 8-1c.

3. The third step is determining the geographic extent of all project impacts. By combining or overlaying the zones of effect illustrated in Figures 8-1b and 8-1c, the project biologist can determine the geographic extent of all project effects (Figure 8-1a). Some projects may have multiple zones of effect that need to be considered simultaneously.

   Based on this combination of all relevant affected areas, the project biologist can then delimit the action area. The action area limits outline the outermost extent of contiguous project-related effects, plus any outlying areas that will sustain project-related effects (such as a wetland mitigation site).

The second example illustrates how an action area is defined for a project involving pile driving in a marine environment. Although other effects such as sedimentation or turbidity could also be generated by project activities, this example assumes that these zones of effect are confined within the area affected by project-related noise. Since the extent of project- related noise represents, geographically, the most far-reaching project effect, the limit of noise impacts is also considered the limit of the action area.

This example also illustrates the different attenuation rates of noise above and below water, demonstrating that noise impacts must be considered in a three-dimensional fashion. Figures 8-2a and 8-2b illustrate the aerial and underwater extent of the action area defined for this project, respectively.

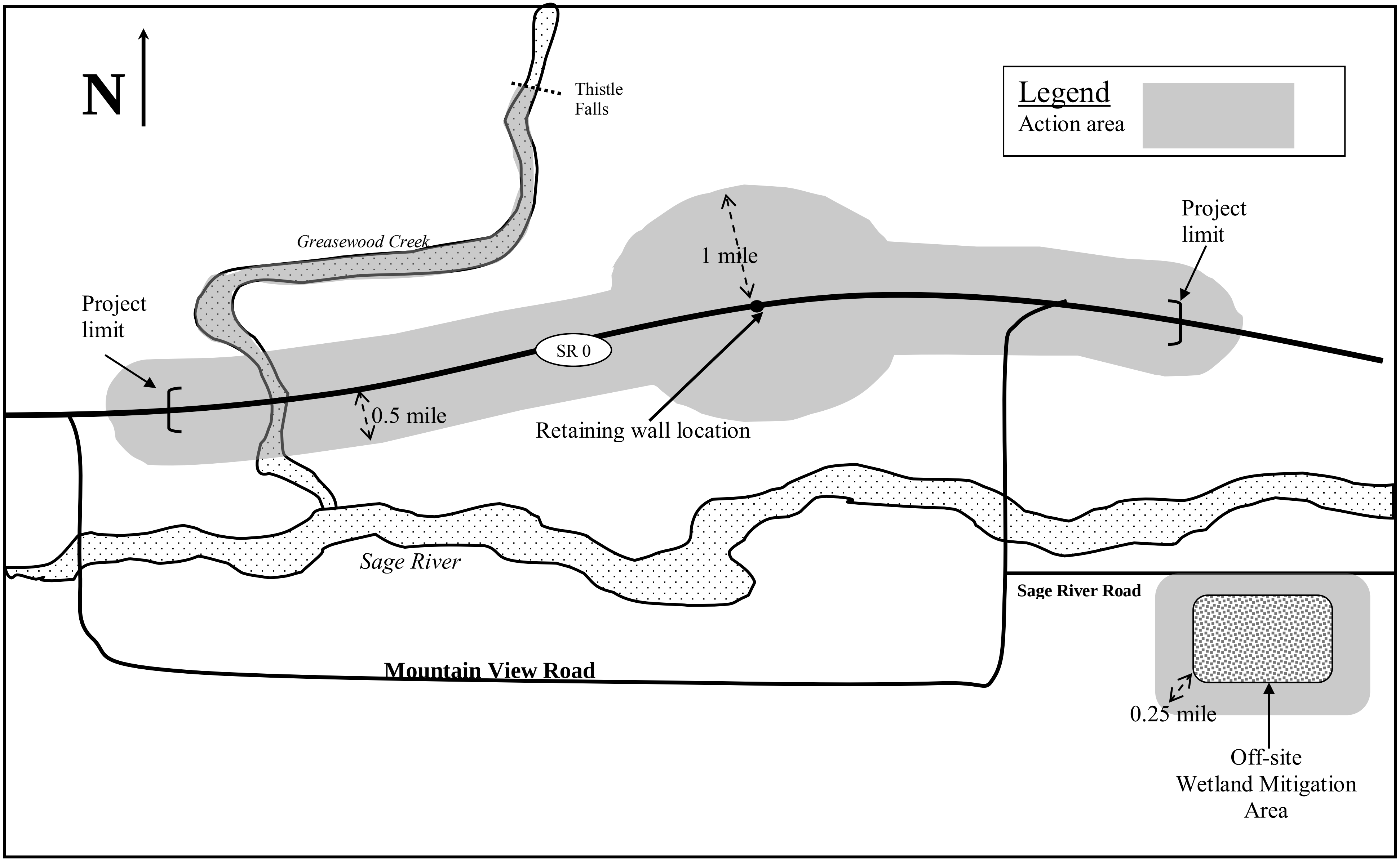

Figure 8-1a. Example showing project vicinity and action area limits.

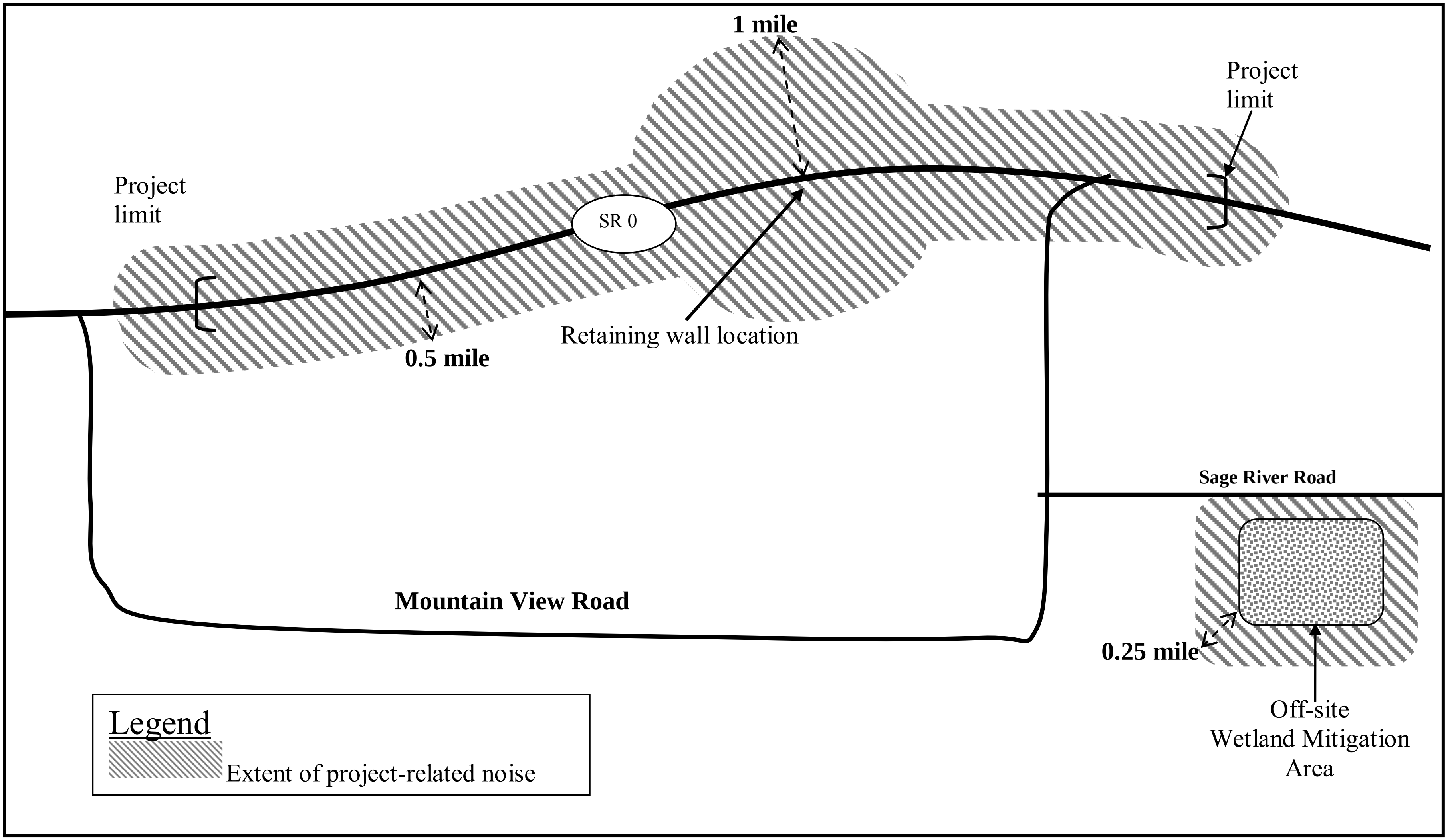

Figure 8-1b. Example showing extent of project-related noise.

The project consists of roadway widening, retaining wall construction, and a culvert replacement. The project limits shown above are the beginning and end points for the widening corridor. Noise associated with roadway widening is expected to extend 0.5 miles from the roadway. Construction of the retaining wall requires impact pile driving, and the extent of construction noise expands to 1 mile around this activity. The culvert replacement requires closure of SR 0 so traffic will be routed to Mountain View Road. A wetland mitigation site will be constructed near Sage River Road. Due to construction equipment noise at the mitigation site, project-related noise extends 0.25 mile around the wetland mitigation site.

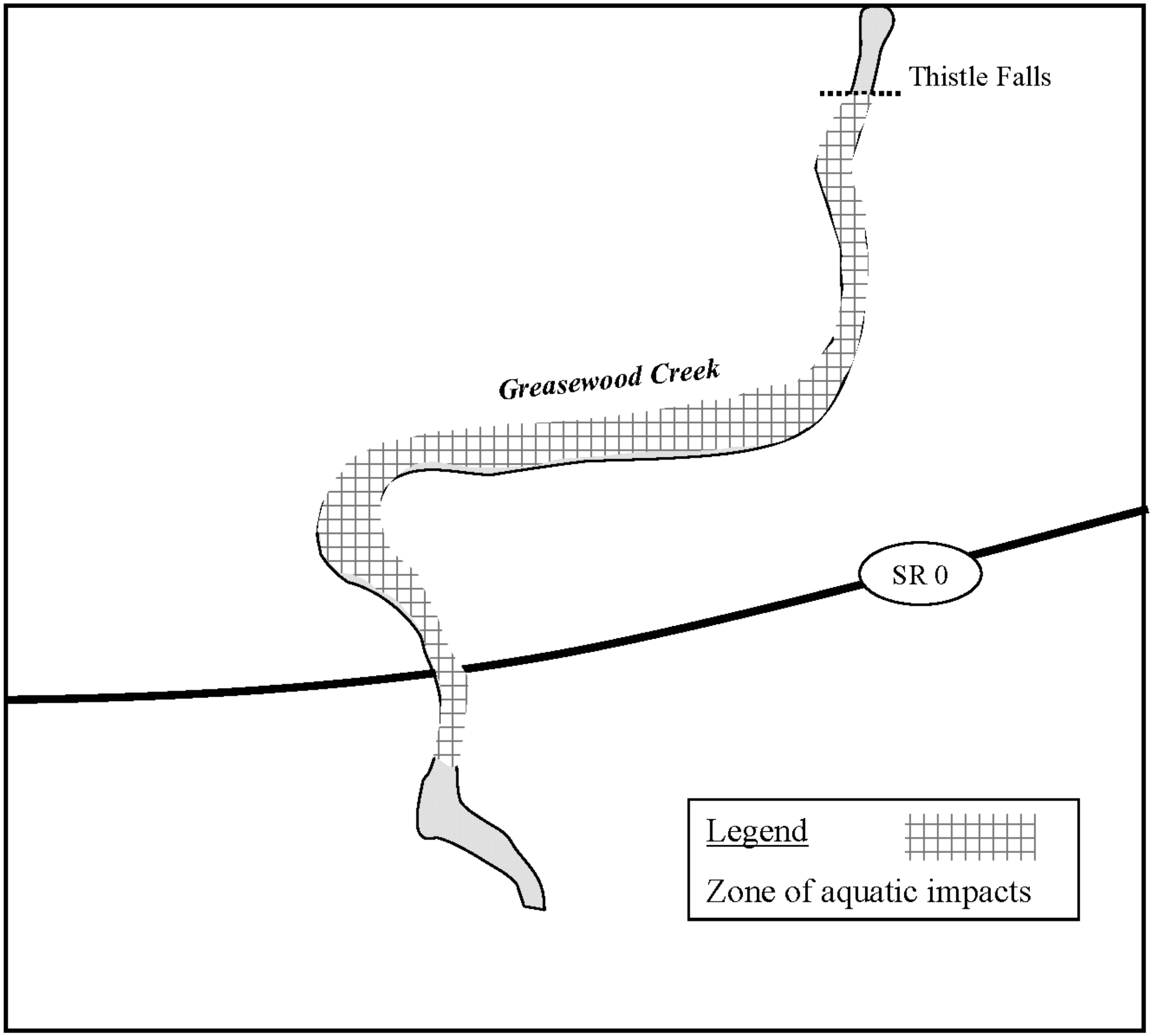

Figure 8-1c. Example showing extent of project-related aquatic effects.

The project will conduct in-water work by replacing a failed culvert on SR 0 over Greasewood Creek. The culvert has not allowed fish passage for several years, but after project completion, fish can access upstream habitat to Thistle Falls, which is an impassable natural barrier. This access to habitat is a beneficial effect, and therefore constitutes a project-related aquatic effect.

Aquatic effects extend from 300 feet downstream of the project area (*WSDOT–Washington State Department of Ecology Water Quality Implementing Agreement*) to approximately 3 miles upstream (Thistle Falls).

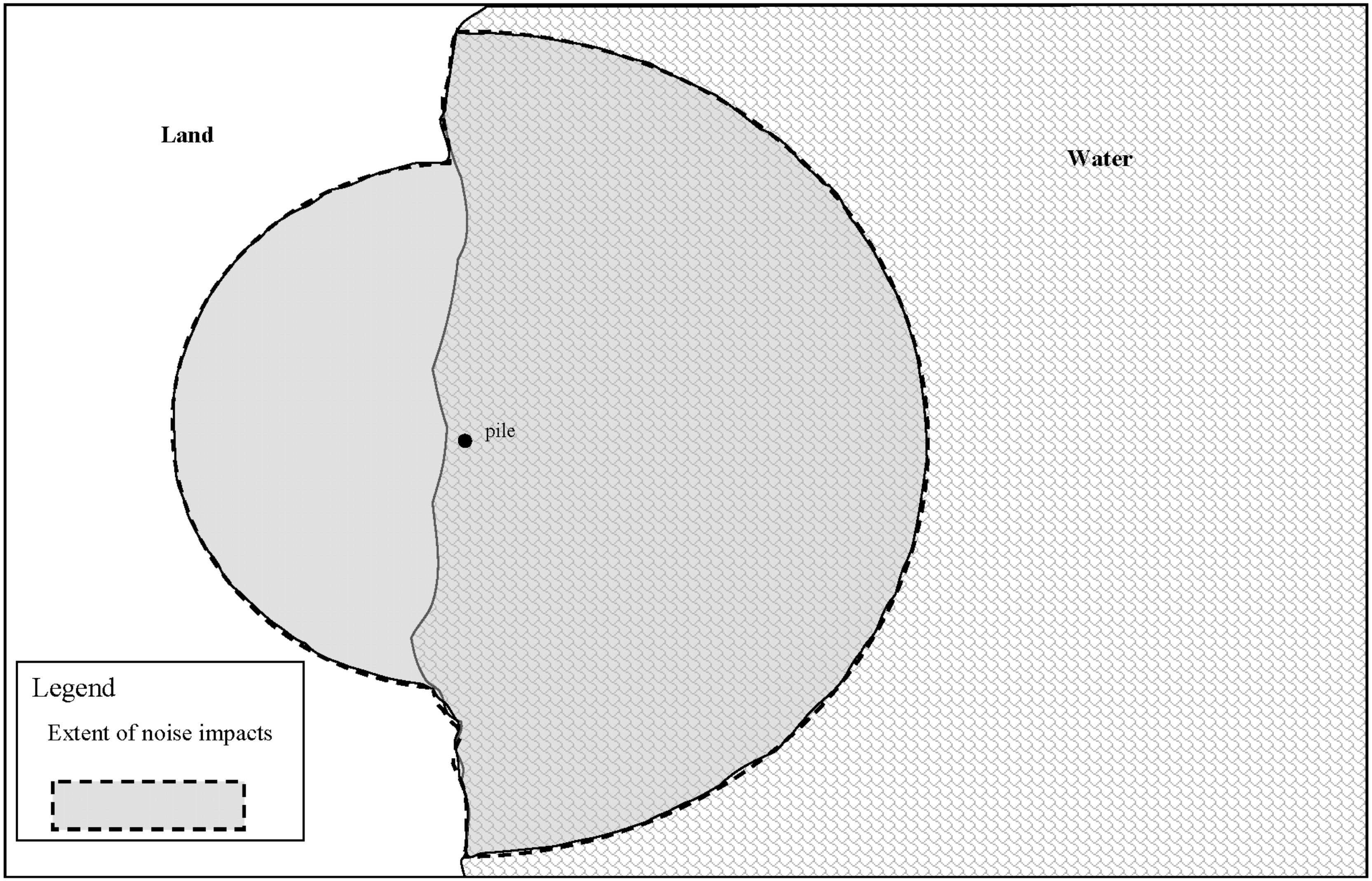

Figure 8-2a. Extent of project-related noise from pile driving in the near-shore marine environment (plan view).

This example shows the approximate extent of project-related noise (over land and water) resulting from marine pile driving activities. Noise attenuates at different rates over land (soft site) and over water (hard site), which explains the difference in radii. The limit of project-related noise is the distance at which noise from construction is indistinguishable from baseline noise.

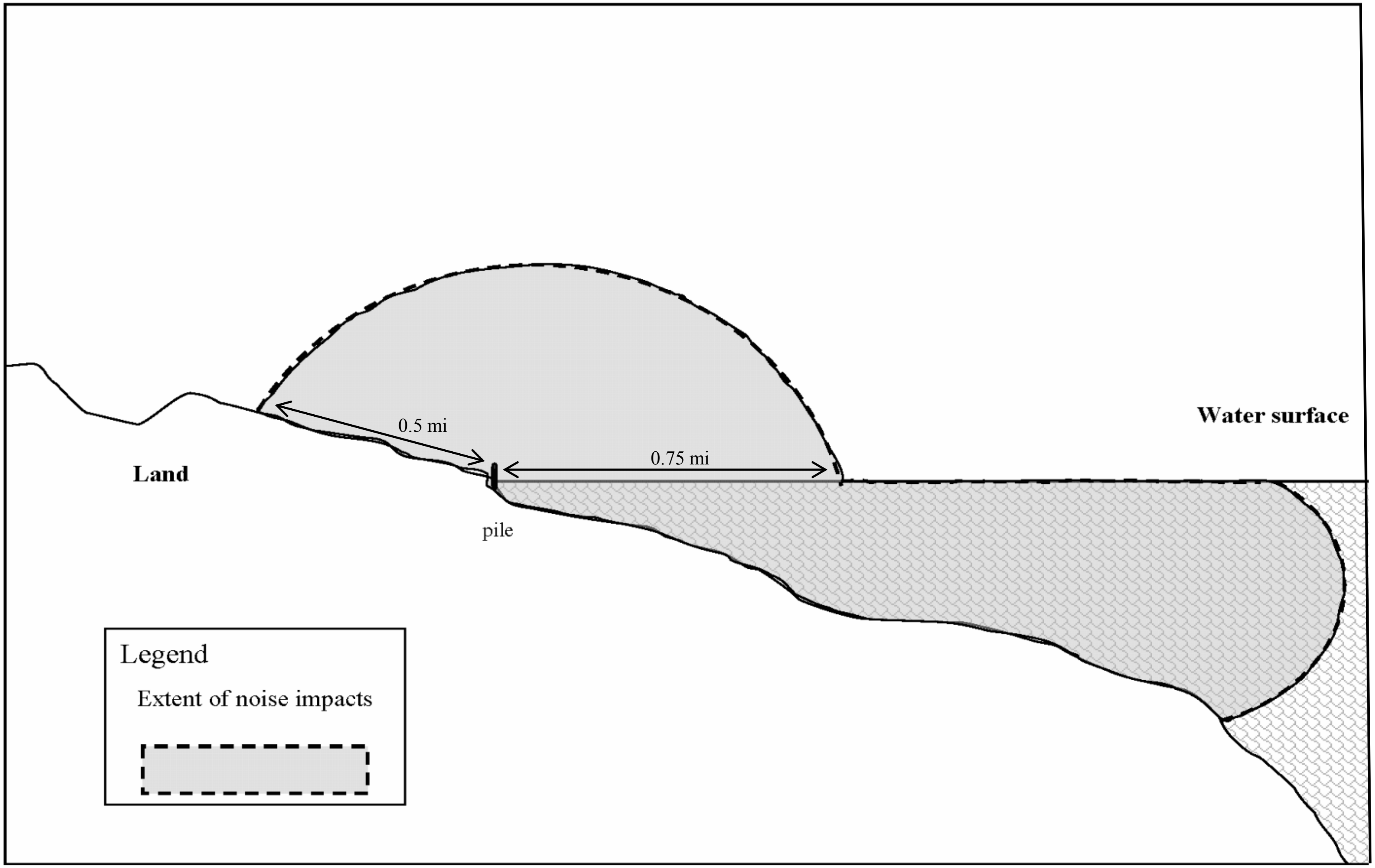

Figure 8-2b. Extent of project-related noise from pile driving in the near-shore marine environment (cross-sectional view).

This example displays the 3-dimensional aspect of noise extent. Note the difference in radius between over-land and over-water spreading.

8.1.2 Sample Biological Assessment Descriptions

One example of how to define a project's action area, accompanied by an aerial photograph illustrating the extent of the action area (Figure 8-3), is provided below. The project entails rebuilding a bridge along SR 0. The action area encompasses the direct effects of the proposed action (noise and sedimentation/hydraulic impacts) as well as effects associated with the equipment access routes to be used for the project. In this example, the outer limits of the action area are determined by combining these multiple zones of effect.

The action area includes all areas that could be affected by the proposed project and is not limited to the actual work area. Noise and disturbance from construction activities have the potential to extend 500 feet outward from the project area. Project-induced sediment conveyance and hydraulic effects could affect Dogwood Creek and its stream banks up to 250 feet upstream of the bridge and 500 feet downstream of the bridge (Figure 8-3). Equipment access routes will generate impacts on both banks of Dogwood Creek, but these access routes are within the 500-foot action area.

Consequently, the action area has a radius of 500 feet in all directions from the project footprint, encompassing noise, equipment access, and sediment/hydraulic zones of effect. These distances are established with the confidence that they include all areas of conceivable impact associated with the proposed project.

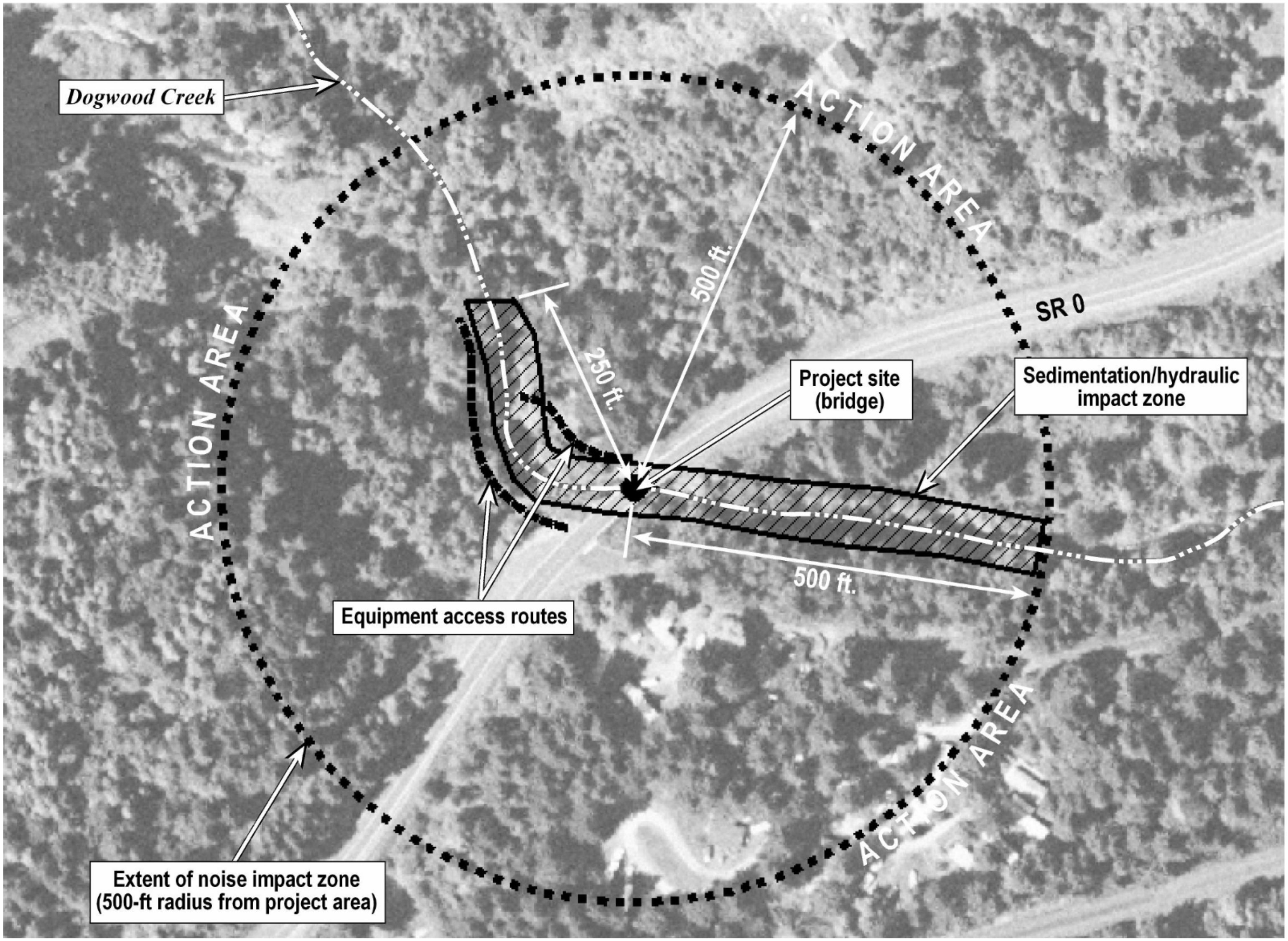

Figure 8-3. Detail of project action area including zone of effect for project-related noise sedimentation/hydraulic effects, and effects associated with the equipment access route.

a /ba manual 10- 8 0 action area.doc

9.0 Environmental Setting

Contents

Tables

9.0 Environmental Setting

Chapter Summary

- The BA should provide a brief description of general habitat and environmental conditions within the action area and summarize previous actions or developments and their relevance to the status of listed species in the action area.
- For terrestrial and marine species, environmental conditions within the action area that are pertinent to the species' habitat requirements should be described.
- The environmental baseline discussion should describe habitat elements, significant to the species being addressed, that will be affected by the proposed action or that would affect the use of the action area by listed species.
- The environmental baseline analysis of freshwater systems can be completed at multiple scales.
- If bull trout or bull trout critical habitat is addressed in a BA, the USFWS matrix of pathways and indicators should be used to document the pathways of effects and indicators of those effects to the species or habitat.
- Detailed environmental baseline discussions for each of the USFWS pathways and indicators addressed in the BA should be included in the BA appendices.
- Summary tables of freshwater baseline conditions should be included within the text of the BA.
- At a minimum, the BA should assess the USFWS pathways and indicators that could be affected by the proposed action and that could result in effects on bull trout or bull trout suitable and critical habitat.
- The NOAA Fisheries matrix of pathways and indicators can be used as a diagnostic tool to analyze pathways of effects. However NOAA Fisheries no longer requires the matrix to be in all BAs.
- For projects with stormwater impacts that will potentially affect listed fish species under NOAA's jurisdiction, only the water quality indicators (temperature, sediment, and chemical contamination) should be included in the body of the BA. For those projects, a detailed description of the

indicators should be provided in the body of the BA. The status of the water quality indicators is used in the stormwater effects analysis (see CHAPTER 17 – STORMWATER BMP IMPACT ASSESSMENT).

- For projects without stormwater impacts that will potentially affect listed fish species under NOAA's jurisdiction, the NOAA Fisheries matrix of pathways and indicators does not need to be included in the BA.

This chapter discusses the types of information to be included in a BA pertaining to existing environmental conditions within the action area. The discussion of baseline environmental conditions is usually divided into two sections: 1) terrestrial and marine species, and 2) freshwater aquatic species. Accordingly, this chapter is divided into two corresponding sections.

9.1 Terrestrial and Marine Species: Environmental Baseline Information

This section provides guidance for documenting environmental conditions within the action area that are relevant for terrestrial and marine species that may be present.

The project biologist should describe existing environmental conditions and habitat features (with a focus on suitable habitat and critical habitat) within the action area. Some project biologists first describe these conditions in general, and then provide more detail including findings from site visits. Other BA authors combine general and specific information regarding environmental conditions and species present.

One excellent resource for describing existing environmental conditions within watersheds is the Habitat Limiting Factors report series prepared by the Washington Conservation Commission, available by water resource inventory area (WRIA) at <http://www.scc.wa.gov/index.php/174-Salmon-Habitat-Limiting-Factors-Reports/View-category/Page-6.html>.

The baseline discussion should summarize the actions that have (and continue to) occur in the action area and describe how these actions have influenced environmental conditions and the status of the species in the action area. The species' response to the resulting environmental conditions should also be included in the baseline discussion. The baseline discussion should focus on the trends or characteristics in the environment of the action area that are relevant to the listed species.

The environmental conditions that are pertinent to the terrestrial and marine species addressed in the BA should be described in detail, to provide reviewers with a clear sense of the features present and how they may be affected by the proposed action. Habitat characteristics that are suitable for various behavioral or life history requirements (e.g., foraging, nesting, denning, dispersal, and migration) should also be described in detail. These characteristics will vary depending upon the species addressed in the BA and their respective habitat requirements. In addition, the environmental baseline section also establishes the starting point for the effects analysis for critical habitat and should include a detailed description of the current functional condition of the individual primary constituent elements (if defined) within the action area. The discussion should describe baseline or existing habitat elements or functions that will be affected by the proposed project activities in detail.

The condition of the environmental baseline will influence the effects analysis in that the response of the species and critical habitat in the action area to the proposed action will depend, in part, on existing environmental conditions.

9.2 Freshwater Aquatic Species: Environmental Baseline Information

This brief section provides guidance for addressing and documenting aquatic environmental baseline conditions in relation to a project. In addition, general information and resources for this analysis and the NOAA Fisheries and USFWS matrices and tables are provided.

Both NOAA Fisheries and USFWS have developed documents to outline frameworks for providing consistent and logical lines of reasoning to aid in determining when, where, and why listed species suffer adverse effects. The documents provide diagnostic matrices, environmental baseline checklists, and dichotomous keys for making determinations of effect and documenting expected incidental *take*. The tables facilitate the documentation of the environmental baseline conditions and potential effects of the proposed action on relevant indicators for the aquatic environment. These documents originally were developed to provide the information needed to evaluate effects of proposed and ongoing land management actions of the U.S. Forest Service and U.S. Bureau of Land Management related to the persistence and potential recovery of proposed and listed salmonids. As a result, the matrices are not well adapted for characterizing conditions in urban areas or specific locations within a watershed. However, the matrices can aid project biologists in diagnosing pathways of effects and indicators of those effects.

For BAs that include effects to bull trout or bull trout critical habitat, the USFWS pathway and indicator matrix should be included in the body of the document, with a brief discussion of each indicator that could be potentially affected by project activities. The pathways and indicators that could be affected by a proposed action and that could result in effects on listed species and critical habitat should be assessed within the body of the BA. The checklist for documenting the environmental baseline and effects of the proposed action(s) on relevant indicators (see Table 9-7) should also be included in the body of the BA. Text to accompany the indicators that will not be affected by a proposed action can be placed in an appendix of the BA.

The NOAA Fisheries matrix can be used as an aid for diagnosing pathways of effects and indicators of those effects. However it is no longer required that all the pathways and indicators in matrix document be analyzed in a BA. Projects with stormwater impacts that will potentially affect listed fish species under NOAA's jurisdiction, will need to do a detailed description of the baseline water quality conditions (temperature, sediment, and chemical contamination) in the body of the BA. The checklist for documenting the environmental baseline of the water quality indicators and effects of the proposed action(s) on those indicators (see Table 9-5) should also be included in the body of the BA. The water quality indicators are used to analyze potential stormwater impacts to listed fish species and their suitable or critical habitats (Refer to CHAPTER 17 – STORMWATER BMP IMPACT ASSESSMENT for more information).

9.2.1 The Importance of Scale in Analysis of Environmental Baseline Conditions

In describing the environmental baseline conditions for projects potentially affecting aquatic species, a project biologist should think carefully about what scale is most appropriate for their analysis before assessing whether baseline indicators and pathways are properly functioning, at risk, or are not properly functioning at the action area scale, the project setting scale, and/or the watershed scale. NOAA Fisheries has a preference for this information being evaluated at the watershed scale. However it can be useful to catalogue conditions and impacts at a smaller scale particularly if the area of aquatic impacts does not mirror the action area defined for the project.

The project biologist may begin by characterizing baseline conditions at a project footprint or zone of effect scale, an action area scale, and/or a watershed scale, and then subsequently analyzing the impacts of the project by juxtaposing the project impacts at different scales within the watershed. This form of analysis provides greater contextual information for determining the small- and large-scale impacts of a project.

Some BAs begin with a detailed project setting or a watershed description immediately followed by a discussion of environmental baseline conditions pertaining to the action area. This approach allows the author to present a scaled view of the environmental conditions in the watershed versus the action area. Another possible approach would be to provide a scaled discussion of the action area versus the location of proposed work or a smaller zone of effect within the larger action area. In some projects, an author may choose to provide general information at the environmental setting or watershed level and detailed environmental baseline information only at the smallest applicable scale.

For example, a project biologist may plan to discuss environmental baseline conditions and impacts on them at a large scale juxtaposed with a discussion of environmental baseline conditions at the action area scale, to include in the ENVIRONMENTAL BASELINE OF ACTION AREA section of the BA. Similarly, a project biologist may choose to evaluate environmental baseline conditions only at the action area scale juxtaposed with a description of conditions at the zone of effect scale.

For projects that may affect designated or proposed critical habitat, the environmental baseline section should include a detailed description of the current functional condition of the individual PCEs within the action area. The subsequent analysis of project effects will focus on impacts upon specific PCEs. The condition of the environmental baseline will influence the effects analysis in that the effects on the critical habitat in the action area to the proposed action will depend, in part, on existing environmental conditions.

9.3 Information and Resources

There are several sources of information pertaining to assessments of environmental baseline conditions:

- *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NOAA Fisheries 1996).
- *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale* (USFWS 1998).
- Washington Conservation Commission 1999–2003 Limiting Factors Analysis reports for Washington state WRIAs. Reports are online at <http://www.scc.wa.gov/index.php/174-Salmon-Habitat-Limiting-Factors-Reports/View-category/Page-6.html>.
- Clean Water Act Section 303(d) lists provided by the Department of Ecology for threatened waters in the state of Washington, available online at <http://www.ecy.wa.gov/programs/wq/303d/index.html>.
- *A Catalog of Washington Streams and Salmon Utilization*, Volumes 1 (Puget Sound) and 2 (Coastal). Washington Department of Fisheries. November 1975.
- 1998 Washington State Salmon and Steelhead Stock Inventory (SASSI) – Bull trout appendix. Washington Department of Fish and Wildlife and Western Washington Treaty Tribes. Available at <http://wdfw.wa.gov/publications/pub.php?id=00193>.
- 2000 Washington State Salmon and Steelhead Stock Inventory (SASSI) – Coastal cutthroat trout appendix. Washington Department of Fish and Wildlife and Western Washington Treaty Tribes. Available at <http://wdfw.wa.gov/publications/pub.php?id=00192>.
- 2002 Salmonid Stock Inventory, interactive website: <http://wdfw.wa.gov/fish/sasi/>.
- Local municipality or county sensitive areas databases and reports, basin plans, watershed reports, and project BAs contain valuable site-specific

information. Project biologists should contact the nearest county or municipality environmental or planning office to determine the availability of these resources.

In addition to these selections, other references are provided on the compact disc accompanying this manual.

9.4 NOAA Fisheries and USFWS Matrices

The Services have developed matrices and tables to evaluate the effects of proposed on ongoing land management actions. The NOAA Fisheries matrix is no longer included in BAs except to detail water quality conditions (temperature, sediment, and chemical contamination) for the stormwater analysis (see CHAPTER 17 – STORMWATER BMP IMPACT ASSESSMENT for more information). The USFWS matrix should be used for assessing and documenting environmental baseline conditions in the action area of proposed projects potentially affecting bull trout or bull trout critical habitat. These tools are provided in Tables 9-4 through 9-7.

Table 9-4. NOAA Fisheries matrix of pathways and indicators.

Pathway	Indicators [a]	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	Temperature	50–57ºF [b]	57-60º (spawning) 57-64º (migration &rearing) [c]	> 60º (spawning) > 64º (migration & rearing) [c]
	Sediment/turbidity	<12% fines (<0.85 mm) in gravel [d], turbidity low	12-17% (west-side) [d], 12-20% (east-side) [c], turbidity moderate	>17% (west-side) [d], >20% (east side) [c] fines at surface or depth in spawning habitat [c], turbidity high
	Chemical contamination and nutrients	Low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no Clean Water Act 303(d) designated reaches	Moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one Clean Water Act 303(d) designated reach [f]	High levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one Clean Water Act 303(d) designated reach [f]
Habitat Access	Physical barriers	Any manmade barriers present in watershed allow upstream and downstream fish passage at all flows	Any manmade barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows	Any manmade barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows
Habitat Elements	Substrate	Dominant substrate is gravel or cobble (interstitial spaces clear), or embeddedness <20% [d]	Gravel and cobble is subdominant, or if dominant, embeddedness 20-30% [d]	Bedrock, sand, silt or small gravel dominant, or if gravel and cobble dominant, embeddedness >30% [c]
	Large woody debris	Coast: >80 pieces/mile >24-inch diameter, >50 ft. length; [e] East side: >20 pieces/ mile >12-inch diameter, >35 ft. length; [c] and adequate sources of woody debris recruitment in riparian areas	Currently meets standards for properly functioning, but lacks potential sources from riparian areas of woody debris recruitment to maintain that standard	Does not meet standards for properly functioning and lacks potential large woody debris recruitment
	Pool frequency channel width # pools/mile [g] 5 feet 184 10 inches 96 15 inches 70 20 inches 56 25 inches 47 75 inches 23 100 inches 18	Meets pool frequency standards (left) and large woody debris recruitment standards for properly functioning habitat (above)	Meets pool frequency standards but large woody debris recruitment inadequate to maintain pools over time	Does not meet pool frequency standards

Table 9-4 (continued). NOAA Fisheries matrix of pathways and indicators.

Pathway	Indicators [a]	Properly Functioning	At Risk	Not Properly Functioning
Habitat Elements (continued)	Pool quality	Pools >1 meter deep (holding pools) with good cover and cool water [d], minor reduction of pool volume by fine sediment	Few deeper pools (>1 meter) present or inadequate cover/temperature [d], moderate reduction of pool volume by fine sediment	No deep pools (>1 meter) and inadequate cover/temperature [d], major reduction of pool volume by fine sediment
	Off-channel habitat	Backwaters with cover, and low energy off-channel areas (ponds, oxbows, etc.) [d]	Some backwaters and high energy side channels [d]	Few or no backwaters, no off-channel ponds [d]
	Refugia (important remnant habitat for sensitive aquatic species)	Habitat refugia exist and are adequately buffered (e.g., by intact riparian reserves); existing refugia are sufficient in size, number and connectivity to maintain viable populations or sub-populations [h]	Habitat refugia exist but are not adequately buffered (e.g., by intact riparian reserves); existing refugia are insufficient in size, number and connectivity to maintain viable populations or sub-populations [h]	Adequate habitat refugia do not exist [h]
Channel Condition & Dynamics:	Width/depth ratio	<10[c,e]	10–12 [n]	>12 [n]
	Stream bank condition	>90% stable; i.e., on average, less than 10% of banks are actively eroding [c]	80–90% stable	<80% stable
	Floodplain connectivity	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly
Flow/Hydrology:	Change in peak/base flows	Watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	Some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	Pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in drainage network	Zero or minimum increases in drainage network density due to roads [i,j]	Moderate increases in drainage network density due to roads (e.g., 5%) [i,j]	Significant increases in drainage network density due to roads (e.g., 20-25%) [i,j]
Watershed Conditions:	Road density & location	<2 mi/mi^2 [l], no valley bottom roads	2–3 mi/mi^2, some valley bottom roads	>3 mi/mi^2, many valley bottom roads

Table 9-4 (continued). NOAA Fisheries matrix of pathways and indicators.

Pathway	Indicators [a]	Properly Functioning	At Risk	Not Properly Functioning
Watershed Conditions (continued):	Disturbance history	<15% ECA (entire watershed) with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area (except AMAs), 15% retention of LSOG in watershed [k]	<15% ECA (entire watershed) but disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area (except AMAs), 15% retention of LSOG in watershed [k]	>15% ECA (entire watershed) and disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; does not meet NWFP standard for LSOG retention
	Riparian reserves	The riparian reserve system provides adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact),and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/ composition >50% [m]	Moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian reserve system, or incomplete protection of habitats and refugia for sensitive aquatic species (70-80% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition 25-50% or better [m]	Riparian reserve system is fragmented, poorly connected, or provides inadequate protection of habitats and refugia for sensitive aquatic species (<70% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition <25% [m]

[a] The ranges of criteria presented here are not absolute; they may be adjusted for unique watersheds.

[b] Bjornn, T.C. and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. American Fisheries Society Special Publication 19:83-138. W.R. Meehan, ed.

[c] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

[d] Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

[e] Biological Opinion on Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service, Northwest Region, January 23, 1995.

[f] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

[g] USDA Forest Service. 1994. Section 7 Fish Habitat Monitoring Protocol for the Upper Columbia River Basin.

[h] Frissell, C.A., W.J. Liss, and David Bayles. 1993. An Integrated Biophysical Strategy for Ecological Restoration of Large Watersheds. Proceedings from the Symposium on Changing Roles in Water Resources Management and Policy, June 27-30, 1993 (American Water Resources Association), pp. 449–456.

[i] Wemple, B.C. 1994. Hydrologic Integration of Forest Roads with Stream Networks in Two Basins, Western Cascades, Oregon. M.S. Thesis, Geosciences Department, Oregon State University.

[j] e.g., see Elk River Watershed Analysis Report, 1995. Siskiyou National Forest, Oregon.

[k] Northwest Forest Plan. 1994. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management.

[l] USDA Forest Service. 1993. Determining the Risk of Cumulative Watershed Effects Resulting from Multiple Activities.

[m] Winward, A.H. 1989. Ecological Status of Vegetation as a base for Multiple Product Management. Abstracts 42nd annual meeting, Society for Range Management, Billings MT, Denver CO: Society For Range Management: p. 277.

[n] No reference available.

Table 9-5. NOAA Fisheries checklist for documenting environmental baseline and effects of proposed action(s) on relevant indicators.

	Environmental Baseline			Effects of the Action(s)		
Pathways Indicators	Properly [a] Functioning	At Risk [a]	Not Properly [a] Functioning	Restore [b]	Maintain [c]	Degrade [d]
Water Quality						
Temperature						
Sediment						
Chem. contam./nutrients						
Habitat Access						
Physical barriers						
Habitat Elements						
Substrate						
Large woody debris						
Pool frequency						
Pool quality						
Off-channel habitat						
Refugia						
Channel Cond. & Dynamics						
Width/depth ratio						
Stream bank condition						
Floodplain connectivity						
Flow/Hydrology						
Peak/base flows						
Drainage network increase						
Watershed Conditions						
Road density & location						
Disturbance history						
Riparian reserves						

[a] These three categories of function (*properly functioning*, *at risk*, and *not properly functioning*) are defined for each indicator in the matrix of pathways and indicators (Table 9-4).

[b] For the purposes of this checklist, *restore* means to change the function of an *at risk* indicator to *properly functioning*, or to change the function of a *not properly functioning* indicator to *at risk* or *properly functioning* (i.e., it does not apply to *properly functioning* indicators).

[c] For the purposes of this checklist, *maintain* means that the function of an indicator does not change (i.e., it applies to all indicators regardless of functional level).

[d] For the purposes of this checklist, *degrade* means to change the function of an indicator for the worse (i.e., it applies to all indicators regardless of functional level). In some cases, a *not properly functioning* indicator may be further worsened, and this should be noted.

Table 9-6. USFWS matrix of diagnostics—pathways and indicators.

Diagnostic or Pathway	Indicators [a]	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Species				
Subpopulation characteristics within subpopulation watersheds	Subpopulation size	Mean total subpopulation size or local habitat capacity greater than several thousand individuals. All life stages evenly represented in subpopulation. [b]	Adults in subpopulation are less than 500 but >50. [b]	Adults in subpopulation has less than 50. [b]
	Growth and survival	Subpopulation has the resilience to recover from short-term disturbances (e.g., catastrophic events), or subpopulation declines within one to two generations (5 to 10 years). [b] Subpopulation is characterized as increasing or stable. At least 10+ years of data support this estimate. [c]	When disturbed, the subpopulation will not recover to predisturbance conditions within one generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The subpopulation is reduced in size, but the reduction does not represent a long-term trend. [b] At least 10+ years of data support this characterization. [c] If less data is available and a trend cannot be confirmed, a subpopulation will be considered at risk until enough data is available to accurately determine its trend.	The subpopulation is characterized as in rapid decline or is maintaining at alarmingly low numbers. Under current management, the subpopulation condition will not improve within two generations (5 to 10 years). [b] This is supported by a minimum of 5+ years of data.
	Life history diversity and isolation	Migratory form is present, and subpopulation exists near other spawning and rearing groups. Migratory corridors and rearing habitat (lake or larger river) are in good to excellent condition for the species. Neighboring subpopulations are large, with high likelihood of producing surplus individuals or straying adults that mix with other subpopulation groups. [b]	The migratory form is present but the subpopulation is not close to other subpopulations or habitat disruption has produced a strong correlation among subpopulations that do exist in proximity to each other. [b]	The migratory form is absent and the subpopulation is isolated to the local stream or a small watershed not likely to support more than 2,000 fish. [b]
	Persistence and genetic integrity	Connectivity is high among multiple subpopulations (five or more) with at least several thousand fish each. Each relevant subpopulation has low risk of extinction. [b] Probability of hybridization or displacement by competitive species is low to nonexistent.	Connectivity among multiple subpopulations does occur, but habitats are more fragmented. Only one or two of the subpopulations represent most of the fish production. [b] The probability of hybridization or displacement by competitive species is imminent, although few documented cases have occurred.	Little or no connectivity remains for refounding subpopulations in low numbers, in decline, or nearing extinction. Only a single subpopulation or several local populations that are very small or that otherwise are at high risk remain. [b] Competitive species readily displace bull trout. The probability of hybridization is high and documented cases have occurred.

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Table 9-6 (continued). USFWS matrix of diagnostics—pathways and indicators.

Diagnostic or Pathway	Indicators [a]	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat				
Water quality	Temperature	7-day average maximum temperature in a reach during these life history stages: [b,d] Incubation 2 – 5ºC Rearing 4 – 12ºC Spawning 4 – 9ºC Also, temperatures do not exceed 15ºC in areas used by adults during migration (no thermal barriers).	7 day average maximum temperature in a reach during the following life history stages:[b, d] Incubation <2ºC or 6ºC Rearing <4ºC or 13 - 15ºC Spawning <4ºC or 10ºC Also, temperatures in areas used by adults during migration sometimes exceeds 15ºC.	7 day average maximum temperature in a reach during the following life history stages: [b, d] Incubation <1ºC or >6ºC Rearing >15ºC Spawning <4ºC or > 10ºC also temperatures in areas used by adults during migration regularly exceed 15ºC (thermal barriers present).
	Sediment (in areas of spawning & incubation; address rearing areas under *substrate embeddedness*)	Similar to Chinook salmon,[b] for example: <12% fines (<0.85 mm) in gravel,[e] ≤20% surface fines ≤6 mm. [f,g]	Similar to Chinook salmon: [b] e.g., 12-17% fines (<0.85mm) in gravel, [e] e.g., 12-20% surface fines. [h]	Similar to Chinook salmon [b]: e.g., >17% fines (<0.85mm) in gravel;[e] e.g., >20% fines at surface or depth in spawning habitat. [h]
	Chemical contamination & nutrients	Low levels of chemical contamination from agricultural, industrial, and other sources; no excess nutrients; no Clean Water Act 303(d) designated reaches. [i]	Moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one Clean Water Act 303(d) designated reach. [i]	High levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one Clean Water Act 303(d) designated reach. [i]
Habitat access	Physical barriers (address subsurface flows impeding fish passage under *flow/hydrology*)	Manmade barriers present in watershed allow upstream and downstream fish passage at all flows.	Manmade barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows	Manmade barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows.
Habitat elements	Substrate embeddedness in rearing areas (address spawning & incubation areas under the indicator *sediment*)	Reach embeddedness <20%. [j,k]	Reach embeddedness 20-30%. [j,k]	Reach embeddedness >30%. [e,k]
	Large woody debris (LWD)	Current values being maintained at: On the coast, >80 pieces/mile (>24-inch diameter, >50 ft length), [j] On the east side, >20 pieces/mile (>12-inch diameter, >35 ft length). [l] Adequate woody debris sources available for long- and short-term recruitment.	Current levels are being maintained at minimum levels desired for "functioning appropriately", but potential sources for long term woody debris recruitment are lacking to maintain these minimum values.	Current levels are not at those desired values for "functioning appropriately", and potential sources of woody debris for short and/or long term recruitment are lacking.

Table 9-6 (continued). USFWS matrix of diagnostics—pathways and indicators.

Diagnostic or Pathway	Indicators [a]	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat (continued)				
	Pool frequency & quality	Pool frequency in a reach closely approximates [f]: Wetted width (ft) # pools/mile 0–5 39 5–10 60 10–15 48 15–20 39 20–30 23 30–35 18 35–40 10 40–65 9 65–100 4 (can use formula: pools/mi = 5,280/wetted channel width #channel widths per pool); also, pools have good cover and cool water[e], and only minor reduction of pool volume by fine sediment	Pool frequency is similar to values in "functioning appropriately", but pools have inadequate cover/temperature[e], and/or there has been a moderate reduction of pool volume by fine sediment	Pool frequency is considerably lower than values desired for "functioning appropriately"; also cover/temperature is inadequate[e], and there has been a major reduction of pool volume by fine sediment
	Large pools (in rearing, adult holding, & overwintering reaches of >3 meters in wetted width at base flow)	Each reach has many large pools >1 meter deep. [e]	Reaches have few large pools (>1 meter) present[e]	Reaches have no deep pools (>1 meter)[e]
	Off-channel habitat (see reference 18 for identification of these characteristics)	Watershed has many ponds, oxbows, backwaters, and other off-channel areas with cover; and side-channels are low energy areas.[e]	Watershed has some ponds, oxbows, backwaters, and other off-channel areas with cover; but side-channels are generally high-energy areas[e]	Watershed has few or no ponds, oxbows, backwaters, or other off-channel areas[e]
	Refugia (see checklist footnotes for definition of this indicator)	Habitats capable of supporting strong and significant populations are protected and are well distributed and connected for all life stages and forms of the species.[m, n]	Habitats capable of supporting strong and significant populations are insufficient in size, number and connectivity to maintain all life stages and forms of the species[m, n]	Adequate habitat refugia do not exist[m]
Channel condition & dynamics	Average wetted width/ maximum depth ratio in scour pools in a reach	≤10[h, f]	11–20[f]	>20[f]
	Stream bank condition	>80% of any stream reach has ≥90% stability.[f]	50–80% of any stream reach has ≥90% stability[f]	<50% of any stream reach has ≥90% stability[f]

Table 9-6 (continued). USFWS matrix of diagnostics—pathways and indicators.

Diagnostic or Pathway	Indicators [a]	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat (continued)				
Channel condition & dynamics (continued)	Floodplain connectivity	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly
Flow/hydrology	Change in peak & base flows	Watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology, and geography.	Some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	Pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in drainage network	Zero or minimum increases in active channel length correlated with human caused disturbance.	Low to moderate increase in active channel length correlated with human caused disturbance	Greater than moderate increase in active channel length correlated with human caused disturbance
Watershed conditions	Road density and location	<1 mi/mi^2, [n] no valley bottom roads.	1–2.4 mi/mi^2, [n] some valley bottom roads	>2.4 mi/mi^2 [n]; many valley bottom roads
	Disturbance history	<15% ECA of entire watershed with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area there is an additional criterion of 15% LSOG in watersheds. [o]	<15% ECA of entire watershed but disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area there is an additional criterion of 15% LSOG in watersheds. [o]	>15% ECA of entire watershed and disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; does not meet NWFP standard for LSOG
	Riparian conservation areas (RHCA – PACFISH and INFISH) (riparian reserves – Northwest Forest Plan)	The riparian conservation areas provide adequate shade, large woody debris recruitment, and habitat protection and connectivity in subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact), and adequately buffer impacts on rangelands: percent similarity of riparian vegetation to the potential natural community/ composition >50%.[p]	Moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian conservation areas, or incomplete protection of habitats and refugia for sensitive aquatic species (70–80% intact), and adequately buffer impacts on rangelands : percent similarity of riparian vegetation to the potential natural community/composition 25–50% or better. [p]	Riparian conservation areas are fragmented, poorly connected, or provides inadequate protection of habitats for sensitive aquatic species (<70% intact, refugia does not occur), and adequately buffer impacts on rangelands : percent similarity of riparian vegetation to the potential natural community/composition <25%[p]
	Disturbance regime	Environmental disturbance is short lived; predictable hydrograph, high quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. [b] Natural processes are stable.	Scour events, debris torrents, or catastrophic fire are localized events that occur in several minor parts of the watershed. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, scour events, debris torrents, or high probability of catastrophic fire exists throughout a major part of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. [b] Natural processes are unstable.

Table 9-6 (continued). USFWS matrix of diagnostics—pathways and indicators.

Diagnostic or Pathway	Indicators [a]	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Species and Habitat				
Integration of species and habitat conditions		High habitat quality and connectivity among subpopulations. Migratory form is present. Disturbance has not altered channel equilibrium. Fine sediments and other habitat characteristics influencing survival or growth are consistent with pristine habitat. Subpopulation has resilience to recover from short-term disturbance within one to two generations (5 to 10 years). Subpopulation fluctuating around an equilibrium or is growing. [b]	Fine sediments, stream temperatures, or the availability of suitable habitats have been altered and will not recover to predisturbance conditions within one generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The subpopulation is reduced in size, but the reduction does not represent a long-term trend. The subpopulation is stable or fluctuating in a downward trend. Connectivity among subpopulations occurs but habitats are more fragmented. [b]	Cumulative disruption of habitat has resulted in a clear declining trend in the subpopulation size. Under current management, habitat conditions will not improve within two generations (5 to 10 years). Little or no connectivity remains among subpopulations. The subpopulation survival and recruitment responds sharply to normal environmental events. [b]

[a] The values of criteria presented here are not absolute; they may be adjusted for local watersheds given supportive documentation.

[b] Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. USDA Forest Service, Intermountain Research Station, Boise, ID.

[c] Rieman, B.E. and D.L. Meyers. 1997. Use of redd counts to detect trends in bull trout (*Salvelinus confluentus*) populations. Conservation Biology 11(4): 1015-1018.

[d] Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. In W.C. Mackay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings. P8.

[e] Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

[f] Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitewell, and K.A. Duncan. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-322.

[g] Overton, C.K., S.P. Wollrab, B.C. Roberts, and M.A. Radko. 1997. R1/R4 (Northern/Intermountain regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-346.

[h] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

[i] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

[j] Biological Opinion on Implementation of Interim Strategies for Managing Anadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service, Northwest Region, January 23, 1995.

[k] Shepard, B.B., K.L. Pratt, and P.J. Graham. 1984. Life Histories of Westslope Cutthroat and Bull Trout in the Upper Flathead River Basin, MT. U.S. Environmental Protection Agency report. Contract No. R008224-01-5.

[l] Interior Columbia Basin Ecosystem Management Project Draft Environmental Impact Statement and Appendices.

[m] Frissell, C.A., W.J. Liss, and David Bayles. 1993. An Integrated Biophysical Strategy for Ecological Restoration of Large Watersheds. Proceedings from the Symposium on Changing Roles in Water Resources Management and Policy, June 27-30, 1993 (American Water Resources Association), p. 449-456.

[n] Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams and others. 1997. Chapter 4: Broadscale Assessment of Aquatic Species and Habitats. In T.M. Quigley and S.J. Arbelbide eds. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins Volume III. U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management, Gen Tech Rep PNW-GTR-405.

[o] ECA = equivalent clear-cut area. LSOG = late-stage old growth. NWFP = Northwest Forest Plan.
Northwest Forest Plan. 1994. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management.

[p] Winward, A.H. 1989. Ecological Status of Vegetation as a Base for Multiple Product Management. Abstracts 42nd annual meeting, Society for Range Management, Billings MT, Denver CO: Society For Range Management: p. 277.

Table 9-7. USFWS checklist for documenting environmental baseline and effects of proposed action(s) on relevant indicators.

Diagnostics/ Pathways: Indicators	Population and Environmental Baseline (list values or criteria and supporting documentation)			Effects of the Action(s)			
	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk	Restore [a]	Maintain [b]	Degrade [c]	Compliance with ACS
Subpopulation Characteristics: Subpopulation size							
Growth & survival							
Life history diversity & isolation							
Persistence & genetic integrity							
Water Quality: Temperature							
Sediment							
Chemical contaminants & nutrients							
Habitat Access: Physical barriers							
Habitat Elements: Substrate embeddedness							
Large woody debris							
Pool frequency & quality							
Large pools							
Off-channel habitat							
Refugia [d]							
Channel Conditions & Dynamics: Wetted width/max depth ratio							
Stream bank condition							
Floodplain connectivity							
Flow/Hydrology: Change in peak & base flows							
Drainage network increase							
Watershed Conditions: Road density & location							
Disturbance history							
Riparian conservation areas							
Disturbance regime							
Integration of Species & Habitat Conditions							

[a] For the purposes of this checklist, *restore* means to change the function of a *functioning at risk* indicator to *functioning appropriately*, or to change the function of a *functioning at unacceptable risk* indicator to *functioning at risk* or *functioning appropriately* (i.e., it does not apply to *functioning appropriately* indicators). Restoration from a worse condition to a better condition does not negate the need to consult or confer if *take* will occur.

[b] For the purposes of this checklist, *maintain* means that the function of an indicator does not change (i.e., it applies to all indicators regardless of functional level).

[c] For the purposes of this checklist, *degrade* means to change the function of an indicator for the worse (i.e., it applies to all indicators regardless of functional level). In some cases, a *functioning at unacceptable risk* indicator may be further worsened, and this should be noted.

[d] Refugia = watersheds or large areas with minimal human disturbance having relatively high quality water and fish habitat, or having the potential of providing high quality water and fish habitat with the implementation of restoration efforts. These high quality water and fish habitats are well distributed and connected within the watershed or large area to provide for both biodiversity and stable populations.

(Adapted from discussions in *Stronghold Watersheds and Unroaded Areas* in Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams, and others. 1997. Chapter 4: *Broadscale Assessment of Aquatic Species and Habitats*. *In* T.M. Quigley and S.J. Arbelbide eds. *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins*, Volume III. U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management, Gen Tech Rep PNW-GTR-405).

10.0 Indirect Effects

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10.0 Indirect Effects

Chapter Summary

Indirect effects are those caused by or resulting from the proposed action and are later in time but are still reasonably certain to occur [50 CFR 402.02].

Three examples of indirect effects are:

1. Changes to ecological systems resulting in altered predator/prey relationships
2. Changes to ecological systems resulting in long-term habitat alteration
3. Anticipated changes in human activities, including changes in land use

10.1 General Considerations

Indirect effects are those impacts that are caused by the action and occur later in time (after the action is completed) but are still reasonably certain to occur. The geographic extent of indirect effects of a proposed action and any interrelated or interdependent activities is one component defining the project action area. An interrelated action is an action that is part of a larger action and depends on the larger action for its justification. An interdependent action is defined as an action having no independent utility apart from the proposed action. Interrelated and interdependent activities are discussed in more detail in Part 1 of this training manual (Chapter 3 Components of a Biological Assessment).

This section provides general guidance and includes three examples of indirect effects: changes to ecological systems resulting in altered predator/prey relationships, changes to ecological systems resulting in long-term habitat alteration, and anticipated changes in human activities, including changes in land use. Because of the complex nature of an indirect effect analysis for land use, WSDOT has prepared specific guidance for BA authors (see Section 10.2 WSDOT Guidance—ESA, Transportation, and Development: Assessing Indirect Effects). Section 10.2 includes a 10-step approach for analyzing potential land use indirect effects approved in May 2009 by FHWA, NMFS, USFWS and WSDOT; throughout this section the text from the interagency guidance is provided in shaded text boxes. The 10-step approach is required for WSDOT projects, as well as local agency projects receiving federal funding from FHWA. WSDOT guidance on how to implement the 10-step approach is provided, outside of the shaded text boxes. The following discussion characterizes the three examples of indirect effects associated with transportation projects:

1. Changes to ecological systems resulting in altered predator/-prey relationships

If a project significantly affects the prey species of a listed species, the impact is considered an indirect effect on the listed species. The analysis of the extent of this indirect effect should evaluate the impact of the project on the *population* of the prey species. For example, if a project significantly affects the health or viability of a population of coho salmon in a stream within a watershed identified by USFWS as a bull trout spawning subwatershed, and the impact on coho would be expected to affect bull trout, it would constitute an indirect effect on bull trout in the subwatershed.

2. Changes to ecological systems resulting in long-term habitat alteration

A project can have long-term effects upon the habitat of a listed species. For example, a project that permanently removes riparian vegetation providing habitat functions could have an indirect effect on the species. If a project will increase ambient sound levels in the vicinity of the project, habitat that was once suitable for listed species may become less suitable. If a project changes the hydrology of wetlands that sustain essential prey or forage species or provide suitable habitat or important habitat features for a listed species, the wetland habitat may be altered to the point that it no longer sustains the species. After comparing the potential effects of the habitat alteration to baseline conditions, including consideration of conservation measures, the assessment would then determine if the effects are significant or discountable.

3. Anticipated changes in human activities including changes in land use

This indirect effect occurs when development of undeveloped areas is caused by the action or can reasonably be expected to result from the action. Section 10.2 describes a 10-step approach for analyzing potential land use indirect effects on WSDOT projects and local agency projects receiving federal funds from FHWA. Table 10-1 shows the level of analysis of potential land use indirect effects needed for some common project types. For many projects (e.g., a paving overlay) analyses will be limited to providing brief responses to the questions in steps 1 and 2. For more complex projects (e.g., a new road through an undeveloped area) it may be necessary to provide responses to the questions in steps 1 through 10. More complex analyses will require the involvement of staff with expertise in surface water, traffic patterns, local land development, traffic engineering, transportation, and land use planning.

10.2 WSDOT Guidance—ESA, Transportation, and Development: Assessing Indirect Effects

10.2.1 Introduction

Analyzing land use indirect effects can be very challenging and subject to different interpretations. In May 2009, FHWA NMFS, USFWS and WSDOT published inter-agency guidance on addressing land use indirect effects to assist BA authors with the preparation of these analyses. This guidance appears in the shaded text boxes below. Section 10.2 expands on the interagency guidance by providing more detailed instructions on how to apply the guidance to a range of project types. These instructions are provided for each step under the subheading ***BA Task***.

Under Section 7 of the Endangered Species Act (ESA), the Federal Highway Administration (FHWA), and other federal action agencies, must consult with the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) to determine the effects of their proposed project actions on threatened and endangered species. The Washington State Department of Transportation (WSDOT) is designated to consult on behalf of the FHWA for informal consultations. The consultation process includes an analysis of direct and indirect effects of the action as well as the effects of any interrelated or interdependent activities on listed species. During the Section 7 consultation, questions may arise regarding the relationship of a transportation project to development in adjacent or nearby areas and whether such development is considered an "indirect effect" as defined under the ESA. This document provides general guidance for reviewing and analyzing *only* the indirect effects relationship between transportation and land use development during the consultation process.

This document has resulted from discussions between the USFWS, NMFS, FHWA, Washington state agencies, including WSDOT with input from local agencies and stakeholder groups in 1999 and 2000. This document was updated as a result of coordination with NMFS, USFWS, FHWA, and WSDOT in 2003 and again in 2008. It is assumed that any project undergoing Section 7 consultation would also be evaluated for direct, other indirect and cumulative effects using ESA regulations and other guidance. General guidance on indirect effects and ESA consultation are also found in *ESA Section 7 Consultation Handbook*, March 1998, p 4-27 to 4-29. This document is not intended for NEPA cumulative effects analysis. While there are overlaps, with ESA consultation there are important distinctions between the two regulatory processes. Although this document is created for use in Washington State and focuses on areas covered by the Growth Management Act (GMA), the principles and analyses described below to determine linkages between land uses and transportation facilities will still apply to areas outside the State and outside the jurisdiction of the GMA.

Within the state of Washington, development is managed through the Growth Management Act (GMA). Cities and counties planning under the GMA are required to develop transportation-related plans, as specified in RCW 36.70A.070 (6). The text of RCW 36.70A.070 (6) can be found at the end of this chapter.

10.2.2 Preparing Land Use Indirect Effects Analysis for Biological Assessments

This document describes a step-by-step approach to assess indirect effects by posing a series of questions about the project being reviewed (Section 4.2.3). Figure 10-1 shows this approach in a flow chart. It is recommended that the BA writer work closely with the Services' biologists from the beginning of the consultation to help clarify whether indirect land use effects to listed species will occur as a result of the proposed action.

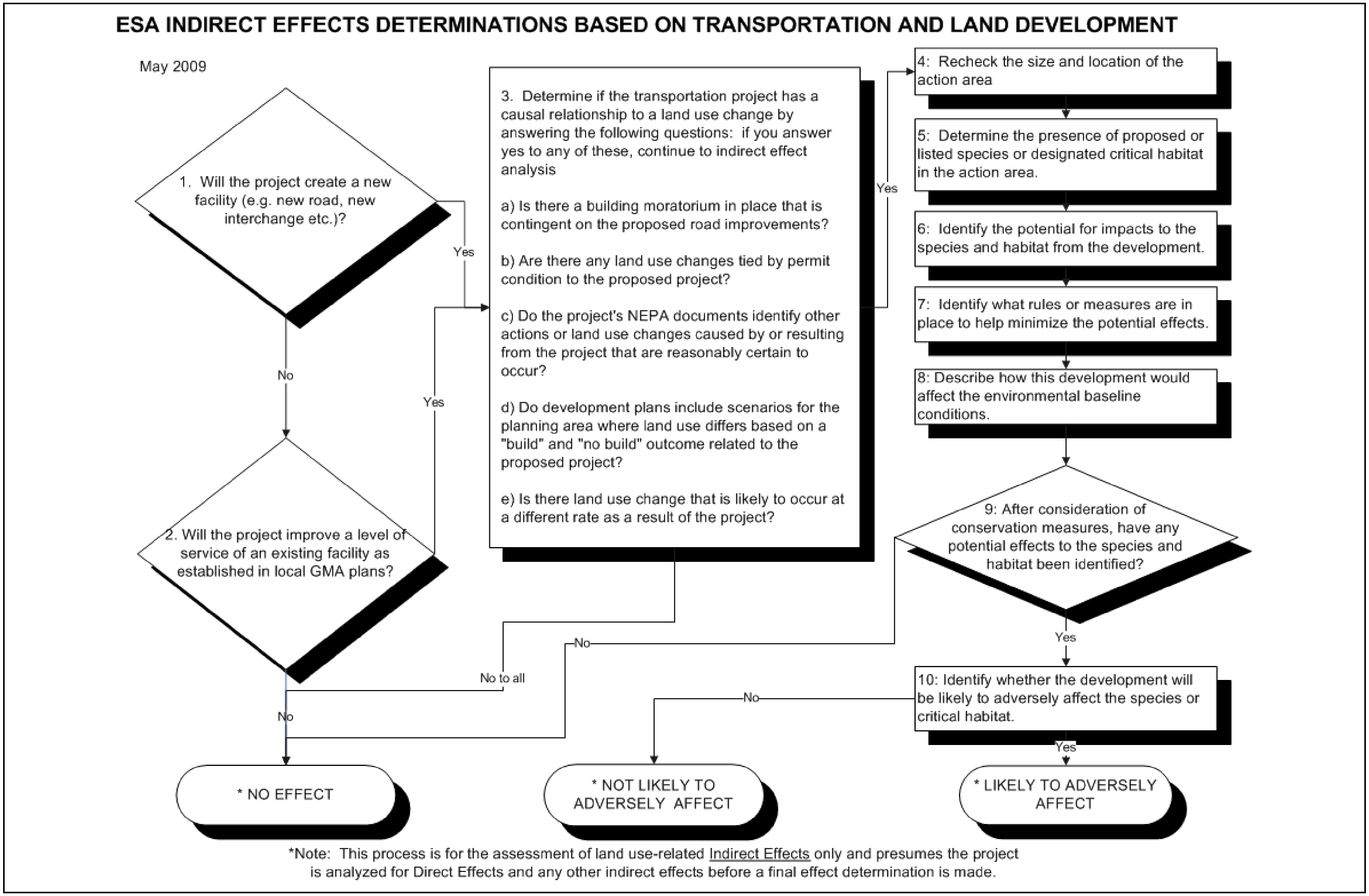

Figure 10-1. Flow chart.

10.2.3 Definitions

The Action: Analysis for ESA consultation must address the proposed action including any interrelated and interdependent actions. Interrelated actions are those that are part of the larger action and dependent on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

The Effect: According to ESA rules and regulations, direct effects occur at or very close to the time of the action itself. Examples could include construction noise disturbance, loss of habitat, or sedimentation that results from construction activity. Indirect effects are those that are caused by or result from the proposed action and are later in time but are still reasonably certain to occur [50 CFR 402.02]. Examples include changes to ecological systems such as predator/prey relationships, long-term habitat changes, or anticipated changes in human activities including changes in land use. Indirect effects may occur outside of the area directly affected by the action. The geographic extent of these effects is the *action area*, defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action."

Indirect effects from transportation projects can include the development or redevelopment of either undeveloped or developed areas when that change is induced by the action or can reasonably be expected to result from the action which is the subject of consultation.

10.2.4 Land Use Indirect Effect Evaluation Process

This section provides instructions on how to apply the guidance for assessing land use indirect effects issued in May 2009 by FHWA, NMFS, USFWS, and WSDOT. This guidance asks a series of questions in 10 steps. Each step is followed by a ***BA Task*** subheading, which provides instructions on how to document responses in BAs and No Effect letters.

Answers to the questions in steps 1 and 2 must be provided for all projects. The answers to the questions in Step 3 are only required for those projects that warrant a "Yes" answer to a question in either step 1 or 2. Steps 4 through 10 apply only to those projects that warrant a "Yes" answer to one or more of the questions in Step 3.

The first steps in the process are to determine whether the proposed project has a potential land use indirect effect.

Step 1. Will the project create a new facility (e.g., new road, new interchange etc.)? *If the answer to this question is yes, go to Step 3.*

To answer this question, it is helpful to understand the type of development.

New facilities have the potential to generate indirect effects that affect listed species and their habitat, because these facilities can potentially cause changes in land development by altering the access to land or significantly changing capacity. Examples of new facilities that could affect capacity or access include the addition of lanes to a roadway, or the creation of new intersections or interchanges from an existing road. New interchanges on limited access roads where access does not exist may also lead to changes in land development.

BA Task

- If the project does not create a new facility, the BA author should concisely state this in the BA indirect effects section. The BA author must also answer the question in Step 2.
- If the project creates a new facility, the BA author should state this in the indirect effects section of the BA; the BA author must also answer the questions in Step 3.
- If the project will create new land access via a new road, new interchange or other new facility, the BA author should state this in the indirect effects section of the BA; the BA author must also answer the questions in Step 3.
- See Table 10-1 for the level of analysis required for some common types of projects.

Table 10–1. Level of analysis of potential land use indirect effects required for some common project types.

Project Type	Project Description	Potential to Cause Land Use Changes?	Analysis Needed
Design standard upgrades that do not improve Level of Service (LOS).	Improve roadway design to engineering standards in terms of lane width, curb, gutter and sidewalk, and other geometrics.	Unlikely	Answer questions in Steps 1 and 2.
Operations and safety improvements that do not improve LOS.	Improvements to enhance traffic operations and safety that include: signalization, traffic control, channelization, median treatments, turn pockets/lanes, and other benefits to traffic flow that do not improve LOS.	Unlikely	Answer questions in Steps 1 and 2.
Pavers.	Repaving is not providing an increase in capacity.	Unlikely	Answer questions in Steps 1 and 2.
Bridge replacements that do not improve LOS.	Replacing bridges without providing an increase in capacity.	Unlikely	Answer questions in Steps 1 and 2.
Increased lane capacity, and improvements to existing interchanges or bridges that increase capacity.	Add physical through-lane capacity to an existing roadway or bridge.	Yes	Answer questions in steps 1 through 3. Steps 4 through 10 are completed only for projects that receive a “Yes” to a question in Step 3.
Roadway extension, new roadway, new interchange, new bridge.	Construct extension of roadway, new roadway on new alignment, new interchange or new bridge.	Yes	Answer questions in steps 1 through 3. Steps 4 through 10 are completed only for projects that receive a “Yes” to a question in Step 3.

Step 2. ***Will the project improve a level of service of an existing facility as established in local comprehensive plans?*** If the answer to this question is yes, go to Step 3.

To answer this question, it is helpful to refer to the project's Purpose and Need statement and consult the project design office to determine what changes in Level of Service (LOS) the project is expected to provide.

LOS standards are adopted by local or state government, depending on who owns the facility. The standards (from A being the best traffic flow, to F being the worst) can be found in the transportation element of the comprehensive plan for local governments and in the state transportation plan for WSDOT/FHWA facilities.

Projects that improve the operation of the transportation system will either maintain or improve the LOS for that facility. This in turn, could allow further development or redevelopment to occur as identified in the local comprehensive plan. For these types of projects, the indirect effects analysis needed to adequately document this may be brief, but it is important to consider the specific facts of the project being evaluated. Improving or maintaining LOS does not necessarily mean that land use change will result. To help determine whether a LOS change will result in an indirect effect related to land use, go to Step 3.

BA Task

This question requires considering a project's purpose and need. In general, stand-alone safety and preservation projects (Table 10-1, project types A through C) do not affect traffic capacity and do not improve a level of service (LOS). Traffic mobility and capacity improvements (Table 10-1, project category E), however, typically will improve a LOS. For simple safety and preservation projects (e.g., a paving overlay), it is sufficient to include a brief statement such as "This preservation project will not affect the LOS."

For more complex operation and safety improvement projects (e.g., changing a lighted intersection to a roundabout) and preservation projects (e.g., a bridge replacement), and all mobility projects, the response to this question must state whether or not the LOS will be improved as well as identify the information source(s) used to arrive at the conclusion. The response will necessitate consulting one or more of the following information sources:

- Personal communication with the local jurisdiction planning department staff
- Traffic study/discipline report (if available)
- Transportation and capital facilities sections of the local jurisdiction's Comprehensive Plan

Projects that are determined to improve the LOS need to answer the questions in Step 3. Projects that document "No" responses to the questions in steps 1 and 2 do not need to continue with the remaining steps.

Step 3. Determine if the transportation project has a causal relationship to a land use change by answering the following questions*: if yes to any of the following criteria, continue with the indirect effect analysis. If no to all of the following criteria, then no further indirect effect analysis is needed.*

a) Is there a building moratorium in place that is contingent on the proposed road improvements?

b) Are there any land use changes tied by permit condition to the proposed project?

c) Do the project's NEPA documents identify other actions or land use changes caused by or resulting from the project that are reasonably certain to occur?

d) Do development plans include scenarios for the planning area where land use differs based on a "build" and "no build" outcome related to the proposed project?

e) Is there land use change that is likely to occur at a different rate as a result of the project?

Answering the questions in Step 3 will require obtaining information about land use planning in the area. The focus should be determining the extent to which the proposed project would influence grown patterns and/or rates in the planning area. Some potential sources of this information are:

1. Applicable sections of municipal/county comprehensive plans that reference the proposed project under consultation.
2. Interviews with local jurisdiction planners.
3. Applicable local and county building permits.
4. Metropolitan Planning Organization (MPO) population forecast models such as Puget Sound Regional Council's DRAM/EMPAL.
5. Funding applications (can be obtained via internet search).
6. NEPA documents including discipline reports.
7. Regional Transportation Investment District.
8. Port Planning Documents (Port of Tacoma, Port of Chehalis, Port of Seattle, etc.).

BA Task

Review relevant documents and consult with the appropriate local agency public works or planning office to determine whether development projects in the area meet criteria 3(a) through 3(e). Seek expertise from planning, traffic engineering, or other areas to conduct this evaluation. Conversations with local jurisdiction or agency staff should be cited as a personal communication in the BA. Information on land use indirect effects contained in the project NEPA documents and other sources should be summarized in the BA.

Projects that receive all "No" answers to the questions in Step 3 do not need to provide additional documentation on land use indirect effects. Projects that receive a "Yes" answer to any of the questions in Step 3 must also provide responses to the questions in steps 4 through 10.

Example 1:
A new interchange and road extension proposed along SR 1 will be constructed between two existing highway interchanges. All of the roads and adjoining lands that will be accessible from the new interchange are currently accessed from the two existing interchanges. However, the new interchange and road extension will likely result in improved freeway access to much of the area located between the existing interchanges. The project definition indicates that the existing SR 1 access points are insufficient to accommodate the anticipated future highway access needs in the service area. The city's comprehensive plan identifies the area in the vicinity of the proposed new road and interchange as occurring within the city's urban growth boundary. The city's comprehensive plan identifies the area as key for urban growth because of its proximity to SR 1 and existing commercial centers. The comprehensive plan also identifies the need for improved transportation facilities as the primary factor limiting growth in this area. As a result, the city has imposed traffic concurrency requirements for future development in this designated growth area.

These proposed improvements are consistent with the city's land use and transportation plans. The above information indicates that the proposed project is intended to serve planned growth.

This project meets *criterion a* because the city has imposed traffic concurrency requirements for future development in this designated growth area that has produced a de facto moratorium. Therefore, further evaluation will be needed to assess potential indirect effects.

Example 2:
WSDOT proposes to improve vehicle capacity at I-7 and SW 120th Street intersection. These improvements will ease congestion, improve roadway deficiencies, and improve safety at the interchanges of I-7 and I-100 with SW 120th Street. To accomplish this, WSDOT will construct a new interchange at SW 120th Street over I-7 and I-100, and add an auxiliary lane along the I-7 corridor from SW 115th Street to 149th Street. Local improvements will include signal modifications, the addition of lanes (road widening), rechannelization, and realignment. Currently, the I-7 corridor does not meet the LOS standards as identified in the county comprehensive plan. The proposed project will improve the existing LOS from LOS D to LOS B.

Review of the county comprehensive plan and zoning ordinances did not identify any instances of building moratoria (*criterion a*) or developments tied to the project by permit condition (*criterion b)*. This finding was further reinforced by information provided by county staff. The county community planning department indicated there were no projects being delayed or prevented from moving forward pending the construction of the I-7 corridor project. Review of the project's NEPA documentation, the land use and transportation discipline reports and the Environmental Assessment in particular, confirmed there were no actions or land use changes that were reasonably certain to occur (*criterion c*) caused by or resulting from the project. No incidences of developments being contingent upon the project were identified by county staff. Evaluation of other major projects under consideration in the action area did not identify any contingent relationships between them and the project (*criterion d*).

The population of the county, which more than doubled during a 20-year timeframe, indicates an increased demand on the regional transportation system. To determine whether the project would speed up the rate of planned development in the area, WSDOT and the county examined the existing level of development within the action area and the land area remaining for future development. The acreage of existing development and land available for development were identified within the zone of influence (see Step 4 for methods to define the zone of influence). Based on the historic rate of development within the zone of influence, it was determined that only 9 percent (41 acres) of the 465 acres of developable land was likely to develop over the next 20 years. In addition, with an average growth rate of 15 acres/year, the available acreage for development would be fully built out a year before the scheduled I-7 corridor project construction start. Because the available acreage for development would fully build-out prior to construction, the rate of development would not change as a result of the project (*criterion e*).

Although the corridor project would improve LOS, under further scrutiny, it does not meet any of the criteria under Step 3. Therefore, the project has no indirect effect related to land use.

Step 4: *Recheck the size and location of the action area.*

Indirect effects occur later in time than the original action and may occur outside of the area directly affected by the action. The entire area that is evaluated in the BA for potential project effects on the listed species is called the action area. When defining the action area it is important to include the area that is directly and indirectly affected by the proposed action. The extent of the action area is based on the physical, chemical and biotic extent of the project effects.

In some more complex cases, determining an action area for a transportation project may involve analysis of surface water, traffic patterns, and local land development. Appropriate expertise in traffic engineering, transportation land use planning, and other technical areas may need to be consulted as the BA is prepared. The purpose is to determine if a project may ultimately affect a listed species by affecting land use.

Defining this action area can be complex for development related indirect effects. An overly generous definition for action area leads to more complexity for cumulative effects analysis and a potential to overestimate effects. This can lead to unnecessary complications, particularly for formal consultation. An undersized action area may fail to adequately characterize the extent of potential impacts. For the BA, the objective is to identify the geographic extent of the effect of land use changes that are caused by the action, and which may ultimately affect the species or their habitat. In some cases, the action area may not be one contiguous area, but could be a patchy distribution.

One method for determining the action area is described below. This may be tailored with respect to project specifics and the available information. Alternative methods may be used; however, an explanation of the methodology may be necessary. It is recommended that such alternatives be discussed with the Services before significant work is accomplished.

Characterize the potential "zone of influence" for change in traffic caused by the project.

A. The zone could be estimated for traffic using projected traffic volumes and focusing on any projected changes in traffic patterns due to the proposed action (i.e., the area accessed through a new interchange).

B. In some cases, this could be generally defined as a corridor along the road including the project and continuing to the closest intersection with a major transportation route such as a state highway.

C. Existing planning units (i.e., travelsheds) exist in some jurisdictions as part of land use planning documents and traffic mitigation analysis. These could be utilized as the action area or in conjunction with subwatershed boundaries as an action area).

D. Detailed analyses of traffic patterns such as origin-destination studies or other studies may be performed as part of planning for certain actions. These may be used where available from project planning materials.

A. Factor in the watershed

To define the action area, overlay the "zone of influence" boundary with the subwatershed (watershed administrative unit) that coincides. For aquatic species, the BA analysis should cover the geographic area defined by the overlap, plus any downstream portions of the subwatershed.

BA Task

Define the zone of influence. The zone of influence for potential land use changes may not match what was identified as the project action area based on direct effects. This can be an iterative process where, once indirect land use effects are considered, the action area may broaden.

Example 1:
Under the SR 1 interchange scenario, the zone of influence includes all roads that will be affected by the new interchange. These include:

- The area in the vicinity of the proposed new road with an imposed traffic concurrency requirement
- All locations where access to SR 1 is most direct or quickest using the new interchange, compared to the existing interchanges

- The roads from which traffic would be diverted as a result of the proposed action (see Figure 10-2).

The action area includes this zone of traffic influence as well as any surrounding area that could be affected by actions that occur as a result of the proposed action. The action area also includes a 0.5-mile buffer from the 80 acres of land where development is reasonably certain to occur as a result of the proposed action, to account for possible construction disturbance, as well as the farthest downstream distance where these future actions could affect water quality or hydrology (see Figure 10-2).

Example 2:
Under the I-7 scenario outlined above, there are no development or land use related indirect effects.

Though the project does not present any development related indirect effects (as described above), the BA author would still need to consider project related impacts that occur later in time. One project related impact that will occur later in time is stormwater runoff resulting from added impervious surface from the project corridor. The zone of influence related to stormwater effects includes up to 530 feet downstream of the project stormwater outfall in Ripple Creek, 260 feet downstream in the tributary to Ripple Creek, and less than 1 foot in Bear Creek.

Step 5:* *Determine the presence of proposed or listed species or designated critical habitat in the action area.

In most cases, the immediate project area probably includes designated critical habitat for salmonid ESUs/DPSs or other ranges of listed species. In some cases, a project might affect listed species only because of its indirect effects.

BA Task

Make certain that all listed species and critical habitat within the action area are included in the analysis. Once the action area is determined, re-check the listing information to ensure it is still adequate for the analysis. The species list should apply to the entire action area, not just the project area. Obtain additional species information if needed. The use of countywide species information is one way to avoid additional species information requests.

Example:
If the action area of indirect effects is larger than the action area of direct effects, the larger action area could extend into the range or habitat associated with a listed species that would otherwise not be analyzed based on direct effects alone.

Using the SR 1 interchange/road extension example portrayed in Figure 10-2, suitable salmonid and eulachon habitat located within the Columbia River would likely be outside of the action area if indirect effects were not included in the analysis, because proposed stormwater treatment for the project includes

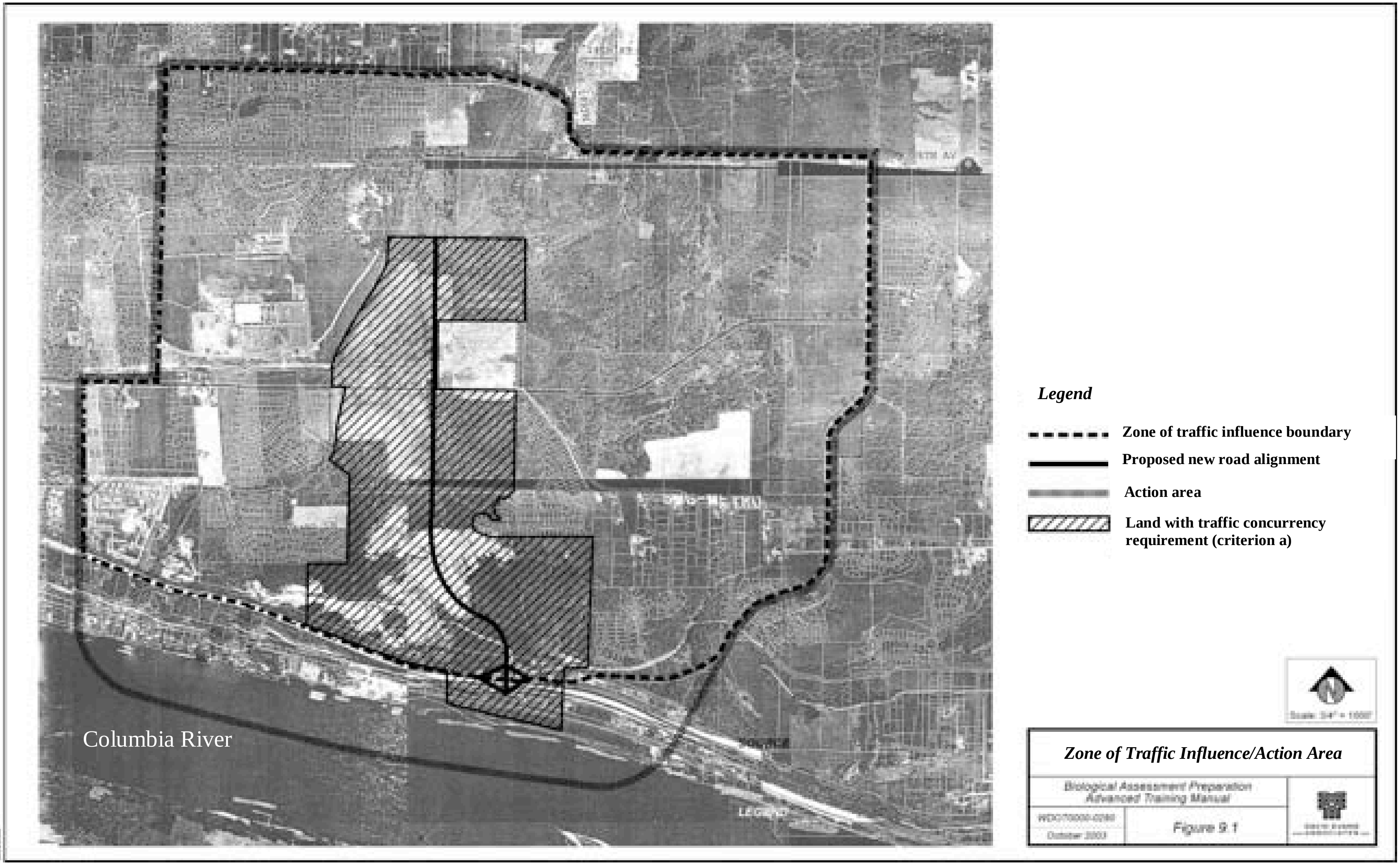

Figure 10-2. SR 1: Zone of influence and action area boundaries.

complete infiltration for new impervious surface. However, when there are indirect effects associated with future development that is contingent on the project, the potential for stormwater impacts could extend into the Columbia River, therefore part of the Columbia River would be included in the action area.

Step 6: ***Identify the potential for impacts to the species and habitat from the development.***

The BA author should evaluate the development in the action area that is contingent on or likely to occur, because of the proposed project. This may include an evaluation of the local jurisdictions comprehensive plan, likely project dependent changes in the existing level of development, likely project dependent growth boundary changes, etc. This information may be available through the local RTPO or MPO.

The key question here is: Does it appear there will be adverse effects to the species and/or its habitat? Consider potential impacts to aquatic habitats, adjacent riparian zones, creation of impervious surfaces and properly functioning conditions as well as direct effects to listed species.

BA Task

Expand the analysis of effects to include the effects of development that is contingent on or likely to occur, because of the proposed project. The analysis of the effects of the development should cover the same elements analyzed for the original project. It may be necessary to estimate conditions for anticipated future land development. The BA author should also complete a stormwater analysis for the impervious surface created from future development as part of the indirect effects evaluation.

Example:
Using the SR 1 interchange/road extension example portrayed in Figure 10-2, the indirect effects (specifically 80 acres of proposed development) could result in two key forms of impact from future development dependent on the proposed action: 1) loss of 80 acres of terrestrial habitat (including 20 acres of mixed deciduous-coniferous forest and 60 acres of unforested land consisting of fallow pasture), and 2) water quality impacts from increased impervious surface and pollutant sources.

Based on the existing zoning of the parcels where development could occur as a result of the proposed action, up to 40 acres of new impervious surface could be generated if each of the parcels is developed to full density. The associated increase in impervious surface area could have an adverse effect on water quality and hydrology in the action area, in turn potentially affecting listed salmonids and Pacific eulachon that rear in the Columbia River.

Step 7: ***Identify what rules or measures are in place to help minimize the potential effects.***

The BA author should note any protection for listed species and habitat provided by existing local Critical Areas Ordinances (CAOs) or other pertinent regulations or agreements pertaining to the action area. This may include protection for riparian or wetland buffers, stormwater regulations, and the implementation and enforcement of existing CAOs.

BA Task

The BA author should identify required conditions or measures that may prevent or minimize adverse effects including:

- Protective measures available to minimize project impacts
- Factors that would help reduce or minimize the potential effect of development caused by the project. These might include plans or commitments by agencies or project proponents outside regulatory requirements.
- Protective conditions required by permits such as an HPA or Section 404 approval

The minimization measures should be incorporated into the discussion of the effects of the proposed action on the environmental baseline.

Example:
Where the SR 1 interchange/road extension example is located, there are many rules and measures in place to help minimize potential effects to species from changes in land use and associated development. These rules and measures are described in the following text:

The local jurisdiction requires all development to comply with its critical areas ordinance. The critical areas ordinance that would apply to the action area for this project is compliant with Section 4(d) of the Endangered Species Act—regulations to conserve species listed as threatened or endangered. Applicable critical areas located within the zone of influence include critical habitats, flood hazard areas, and wetlands. The following text describes how the critical areas ordinance applies to land use within the zone of influence under this project:

- Critical Habitats: The Columbia River is considered a DNR Type S water; therefore activities are regulated within the greater of the 100-year flood plain, or 250 feet of the Columbia River. Through consultation with WDFW, this ordinance is implemented through the city's biologist using best available science and mandates of the GMA to conserve the functional integrity of the habitats needed to perpetually support fish and wildlife populations. This ordinance would be applied to land that could be potentially developed within the zone of influence and located within 250 feet of the Columbia River.
- Flood Hazard Areas: The construction or reconstruction of residential structures (excluding parks, recreational, agricultural or other open space uses that don't involve structures, fill, or equipment storage) within the floodway and the floodplain of the Columbia River is prohibited. Some activities allowed include repairs, reconstruction, or improvements that do not increase ground floor area; and repairs, reconstruction, or improvements to a structure wherein the cost does not exceed 50 percent of its fair market value.

- Wetlands: Wetland protection measures include best available science to protect function and values of wetlands with special consideration to conserve, protect, and enhance anadromous fisheries; promote no net loss of wetlands; encourage restoration and enhancement of degraded, low quality wetlands; complement state/federal wetland measures; and allow reasonable use of property. The provisions apply to all lands, all land uses, and all development activity. No altering of wetlands or wetland buffers is allowed unless the activity is consistent with the ordinance conditions. Depending on the category of the wetland, specific buffer widths are required to protect both water quality and habitat functions.

In addition, the local jurisdiction currently requires all development to provide stormwater treatment consistent with the Department of Ecology's Stormwater Management Manual for Western Washington as specified in their Stormwater and Erosion Control Ordinance. The activities in the zone of influence must apply the standards specified in the manual based on the size and type of development. For example, because the zone of influence is located in an urban area, the provisions of the Stormwater and Erosion Control Ordinance apply to all development activities or redevelopment that results in 2,000 square feet or more of new impervious surface compared to a threshold of 5,000 square feet or more of new impervious area within the rural area. The Stormwater Management Manual for Western Washington is a guidance document and Ecology expects that implementation of the practices identified in the manual will result in compliance with existing regulatory protections for stormwater—including compliance with the Federal Clean Water Act, Federal Safe Drinking Water Act, and the State Water Pollution Control Act. However, even with the adoption of the manual, some impacts to listed fish and habitat may occur, due to the limitations associated with the effectiveness of available BMPs for stormwater treatment.

Other applicable local programs that are tied to the action area for this project include the county's stormwater management program, the Road Maintenance and Street Sweeping Program, and the Low Impact Development Initiative.

- The county's stormwater management program focuses on reducing the harm caused to streams, wetlands, and lakes by stormwater runoff from developed areas and county roads through a systematic, drainage basin-oriented approach. Within the action area for this project, the county has several stormwater improvement projects listed in their capital improvement projects database. By 2011, stormwater from a total of 100 acres will be treated within the action area. The specific acreage of impervious surface that will be treated within the action area by future projects is not available.

- The county's road maintenance and street sweeping program, as with critical areas ordinances, is compliant with ESA. The main objective of the program is to protect salmon and steelhead using approved BMPs for maintenance, and through the implementation of street sweeping to prevent sediment and associated pollutants from entering neighborhood waterbodies (including the Columbia River).

- The county's Low Impact Development Initiative is applied to all new developments within the action area. The techniques provided maximize infiltration capacity to minimize runoff to the Columbia River, and discharges from new development are treated for a variety of pollutants including sediments, heavy metals, oils/grease, and bacteria.

Additional Regulations and BMPS include the following:

- Clean Water Act –Includes National Pollutant Discharge Elimination System (NPDES) permitting program
- Aquatic resource permit conditions—Hydraulic Permit Approval (HPA), the U.S. Army Corps of Engineers (Corps) Nationwide and Individual permits, and clearing and grading permits
- WSDOT Highway Runoff Manual
- Section 9 of the Federal bald eagle protection rules

Given these existing regulations, development resulting from the proposed action will not significantly alter water quality, hydrology, streams, or wetlands, and is not likely to result in significant effects to the listed salmonids and eulachon that rear in the action area.

Step 8:* *Describe how this development would affect the environmental baseline conditions.

The potential effects of the action should be compared to the environmental baseline conditions. NMFS guidance documents and any appropriate guidance from USFWS should be used. Measures in place to protect the species or habitat should be considered in this assessment.

BA Task

As part of the effect determination, describe the existing environmental baseline condition and describe how the direct and indirect effects of the action would likely affect it. Address whether it would degrade, maintain or improve the existing conditions.

Step 9:* *After the consideration of conservation measures in the previous step, identify any of the remaining, potential effects to the species and habitat from the associated land use development.

If the project has any effects on the species (including designated critical habitat), even if they are small or temporary, then a biological assessment will need to be prepared and ESA Section 7 consultation will need to be conducted.

BA Task

Combine this analysis with the evaluation of direct effects. If there is no effect from any development that is likely to result from the action AND there are no other direct or indirect effects, then the project as a whole will have no effects. Combine this analysis with the evaluation of direct effects and proceed with the appropriate documentation (no effect assessment) for the project. Adequate information must be provided to explain and support the conclusions of the analysis.

If the project does have potential effects, then proceed with the biological assessment to determine if the effects are significant or discountable.

> *Example:*
> Because of the existing building moratorium, future development is contingent on the SR 1 interchange/road extension project; the most notable indirect effect of the project include possible development in the vicinity of the interchange and along SR 1 that would not occur without the project. Other impacts include a potential accelerated rate of development of lands along the road extension, which would probably occur eventually, regardless of the proposed action. It is assumed that complete build-out within the action area would result sooner with the proposed project than without these roadway improvements, although this rate of acceleration cannot be quantified, given the difficult task of isolating this factor from the numerous other influences on development.
>
> Because development in the vicinity could affect aquatic habitats within the Columbia River as a result of stormwater runoff from approximately 40 acres of new impervious surface, the proposed action could indirectly result in increased impacts on listed salmonids and Pacific eulachon. However, any future development within the action area, whether directly or indirectly influenced by the project, is not anticipated to have a significant impact on listed species because of the anticipated rate of mixing within the Columbia River and the stringent stormwater treatment requirements of the municipality. As discussed under Step 7, the county has also recently updated its Critical Areas Ordinance to ensure that the baseline conditions in the action area are maintained. The county has also adopted the Department of Ecology's Stormwater Management Manual for Western Washington as specified in their Stormwater and Erosion Control Ordinance. Even with the stormwater management manual, some impacts to listed fish and habitat may occur, due to the limitations associated with the available BMPs for stormwater treatment. While future development may have some impacts associated with build-out and the added impervious that comes with it, the county and municipality have other measures in place to ensure that the impacts from development remain insignificant. Most notably, the county's Stormwater Capital Improvement Program has previously and will continue to construct stormwater projects that include retrofitting of existing facilities to improve water quality. Other local programs applicable to activities within the action area for this project include the county's Road Maintenance and Street Sweeping Program, and Low Impact Development initiatives. Based on this rational, indirect impacts on listed fish species will be minimized.

***Step 10:* Identify whether the development will be likely to adversely affect the species or critical habitat.**

In this step, a determination is made as to the significance of any potential effects on the species (including designated critical habitat). This differentiation will lead either to formal or informal consultation, based on whether the effect is considered insignificant or discountable (informal consultation) or adverse (formal consultation).

Insignificant is generally an effect that is very small in scale, does not reach the level of "take" and cannot be meaningfully measured, detected or evaluated. **Discountable** effects are those which are extremely unlikely to occur.

An adverse effect occurs when the effect cannot be considered insignificant or discountable. If an action significantly degrades the baseline conditions it may be considered an adverse effect by the Services. Actions that result in a "take" of individuals or modify critical habitat, are considered likely to adversely affect the species under consideration. The extent of any adverse effect is considered in the consultation.

If your answer is "No"- then consider this a "Not likely to adversely affect" (NLTAA) for the indirect effects part of the BA. *If the direct effects of the project are also NLTAA*- then proceed with informal consultation and an overall effect determination of NLTAA.

If your answer is "Yes"- then consider this a "Likely to adversely affect" (LTAA); the project will need formal consultation. This analysis must be combined with an analysis of the project's direct effects to complete the biological assessment.

If the consultation results in a no jeopardy opinion, the Services will issue an incidental take statement for take that cannot be avoided. The Services do not have to authorize take for indirect effects over which FHWA has no jurisdiction. The incidental take statement will include Reasonable and Prudent Measures (RPM's) to minimize take, together with terms and conditions. If the consultation results in a jeopardy opinion, reasonable and prudent alternatives may be provided to avoid jeopardy to the species or adverse modification of critical habitat. Also there may be voluntary conservation recommendations by the Services to help further reduce potential effects.

As part of formal consultation the effects of the action must be evaluated in the context of the cumulative effects. These are defined in the ESA as the effects of future state, tribal, local or private activities that are reasonably certain to occur in the foreseeable future within the action area. The larger the action area of the project, the more extensive this aspect of the consultation becomes. Once identified, the cumulative effects are evaluated with the direct and indirect effects of the action for the services' Jeopardy/adverse modification determination to provide the context under which the effects of the action are evaluated. Project impacts in areas where the baseline is severely degraded would be more significant than those where the baseline is functioning well.

BA Task

These effect determinations are for indirect effects only and need to be combined with analysis of direct effects to complete the biological assessment.

Example:
Indirect impacts of growth induced by the proposed SR 1 interchange and road extension project may affect but are not likely to adversely affect Pacific eulachon and listed salmonids.

A *may affect* determination is based on:

- The potential for stormwater impacts that could affect listed Pacific eulachon, listed salmonids, and designated salmonid critical habitat.

A *not likely to adversely affect* determination is based on:

- The applicability of the local government's critical areas ordinance and stormwater treatment requirements, and other applicable measures minimizing impacts on water quality and aquatic habitats for listed Pacific eulachon and listed salmonids.
- Native soils in the action area meet specific permeability and chemical criteria that would both treat and provide flow control before stormwater reaches the Columbia River.
- Flow control for the Columbia River is considered exempt by the USFWS and NOAA.
- Stormwater that enters the Columbia River (receiving waterbody) will be quickly diluted due to the high rate of mixing associated with this large river system.

10.2.5 **Growth Management Act (GMA):** Comprehensive plans — Mandatory elements — Transportation

RCW 36.70A.070 (6): A transportation element that implements, and is consistent with, the land use element.

The transportation element shall include the following subelements:

(i) Land use assumptions used in estimating travel;
(ii) Estimated traffic impacts to state-owned transportation facilities resulting from land use assumptions to assist the department of transportation in monitoring the performance of state facilities, to plan improvements for the facilities, and to assess the impact of land use decisions on state-owned transportation facilities;
(iii) Facilities and services needs, including:
(A) An inventory of air, water, and ground transportation facilities and services, including transit alignments and general aviation airport facilities, to define existing capital facilities and travel levels as a basis for future planning. This inventory must include state-owned transportation facilities within the city or county's jurisdictional boundaries;
(B) Level of service standards for all locally owned arterials and transit routes to serve as a gauge to judge performance of the system. These standards should be regionally coordinated;
(C) For state-owned transportation facilities, level of service standards for highways, as prescribed in chapters 47.06 and 47.80 RCW, to gauge the performance of the system. The purposes of reflecting level of service standards for state highways in the local comprehensive plan are to monitor the performance of the system, to evaluate improvement strategies, and to facilitate coordination between the county's or city's six-year street, road, or transit program and the department of transportation's six-year investment program. The concurrency requirements of (b) of this subsection do not apply to transportation facilities and services of statewide significance except for counties consisting of islands whose only connection to the mainland are state highways or ferry routes. In these island counties, state highways and ferry route capacity must be a factor in meeting the concurrency requirements in (b) of this subsection;
(D) Specific actions and requirements for bringing into compliance locally owned transportation facilities or services that are below an established level of service standard;
(E) Forecasts of traffic for at least ten years based on the adopted land use plan to provide information on the location, timing, and capacity needs of future growth;
(F) Identification of state and local system needs to meet current and future demands. Identified needs on state-owned transportation facilities must be consistent with the statewide multimodal transportation plan required under chapter 47.06 RCW;
(iv) Finance, including:
(A) An analysis of funding capability to judge needs against probable funding resources;
(B) A multiyear financing plan based on the needs identified in the comprehensive plan, the appropriate parts of which shall serve as the basis for the six-year street, road, or transit program required by RCW 35.77.010 for cities, RCW 36.81.121 for counties, and RCW 35.58.2795 for public transportation systems. The multiyear financing plan should be coordinated with the six-year improvement program developed by the department of transportation as required by *RCW 47.05.030;

(C) If probable funding falls short of meeting identified needs, a discussion of how additional funding will be raised, or how land use assumptions will be reassessed to ensure that level of service standards will be met;

(iv) Finance, including:

(A) An analysis of funding capability to judge needs against probable funding resources;

(B) A multiyear financing plan based on the needs identified in the comprehensive plan, the appropriate parts of which shall serve as the basis for the six-year street, road, or transit program required by RCW 35.77.010 for cities, RCW 36.81.121 for counties, and RCW 35.58.2795 for public transportation systems. The multiyear financing plan should be coordinated with the six-year improvement program developed by the department of transportation as required by *RCW 47.05.030;

(C) If probable funding falls short of meeting identified needs, a discussion of how additional funding will be raised, or how land use assumptions will be reassessed to ensure that level of service standards will be met;

(v) Intergovernmental coordination efforts, including an assessment of the impacts of the transportation plan and land use assumptions on the transportation systems of adjacent jurisdictions;

(vi) Demand-management strategies;

(vii) Pedestrian and bicycle component to include collaborative efforts to identify and designate planned improvements for pedestrian and bicycle facilities and corridors that address and encourage enhanced community access and promote healthy lifestyles.

(b) After adoption of the comprehensive plan by jurisdictions required to plan or who choose to plan under RCW 36.70A.040, local jurisdictions must adopt and enforce ordinances which prohibit development approval if the development causes the level of service on a locally owned transportation facility to decline below the standards adopted in the transportation element of the comprehensive plan, unless transportation improvements or strategies to accommodate the impacts of development are made concurrent with the development. These strategies may include increased public transportation service, ride sharing programs, demand management, and other transportation systems management strategies. For the purposes of this subsection (6) "concurrent with the development" shall mean that improvements or strategies are in place at the time of development, or that a financial commitment is in place to complete the improvements or strategies within six years.

(c) The transportation element described in this subsection (6), and the six-year plans required by RCW 35.77.010 for cities, RCW 36.81.121 for counties, RCW 35.58.2795 for public transportation systems, and *RCW 47.05.030 for the state, must be consistent.

Note: *RCW **47.05.030** was amended by 2005 c 319 § 9, changing the six-year improvement program to a ten-year improvement program.

11.0 Cumulative Effects

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11.0 Cumulative Effects

Chapter Summary

- Cumulative effects are effects of future state or private activities that are reasonably certain to occur within the action area.
- Cumulative effects discussions are included only in BAs that require formal consultation, i.e., those with *likely to adversely affect* (LTAA) effect determinations for one or more listed species or designated critical habitats.
- The cumulative effects of a proposed action do not contribute to the definition of the action area.
- Effect determinations for a project are not influenced by cumulative effects.
- The action area defines the geographic scope of the cumulative effects analysis.

This brief chapter discusses the importance of differentiating between cumulative effects and indirect effects. As defined in PART 3, GLOSSARY AND ABBREVIATIONS, cumulative effects are the effects of future state or private activities that are reasonably certain to occur within the action area. (This definition of cumulative effects is different from the one provided under NEPA.) Cumulative effects discussions are included only in BAs that require formal consultation, i.e., those with LTAA effect determinations for one or more listed species or designated critical habitats.

If development occurring in the project vicinity cannot be attributed to or linked to the project (i.e., is not demonstrably interrelated or interdependent) and this is verified by local planners or officials, the subsequent developments are not indirect effects of the proposed project and should be addressed in a cumulative effects analysis.

The cumulative effects of a proposed action do not contribute to the definition of the action area. The action area is defined by the limits of direct and indirect effects of the proposed action and also from interdependent and interrelated activities. Therefore, the effect determinations for a project are not influenced by cumulative effects, even if the cumulative effects occur within the action area. The purpose of the cumulative effects analysis is to aid the USFWS and NOAA Fisheries in making jeopardy and no jeopardy calls for a species, in preparing biological opinions, and in tracking the environmental conditions throughout a general area.

12.0 Effect Determination Language

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12.0 Effect Determination Language

Chapter Summary

- *No effect* (NE) means no effect whatsoever, including any beneficial, highly improbable, or insignificant effects that may result from the project.

- *Not likely to adversely affect* (NLTAA) is the appropriate determination if direct and indirect effects of a federal project (including any interrelated and interdependent activities) are expected to be discountable, insignificant, or completely beneficial.

- *Likely to adversely affect* (LTAA) is the appropriate determination if any adverse effect on listed species may occur as a direct or indirect result of a project (including any interrelated or interdependent actions), and these effects are not discountable, insignificant, or entirely beneficial.

- Effect determination language to use for listed species and designated critical habitat:

  - The project will have **no effect** on *[name of species or critical habitat]* because . . .
    Provide rationale for this effect determination.

  - The project **may affect** *[name of species or critical habitat]* because . . .
    Provide reasons why this species or critical habitat may be affected.

    - But the project **is not likely to adversely affect** *[name of species or critical habitat]* because . . .
      Provide rationale for this effect determination.

      (*or*)

    - And the project **is likely to adversely affect** *[name of species or critical habitat]* because . . .
      Provide rationale for this effect determination.

- Effect determination language to use for proposed species:

  - The project **will not jeopardize the continued existence** of *[name of proposed species]* because . . .
    Provide rationale for this jeopardy call.

- ◻ However, in the event that *[name of proposed species]* becomes listed prior to completion of the project, a provisional effect determination is provided:
  The project **may affect** *[name of proposed species]* because . . .
  Provide reasons why this species may be affected.

  - ◻ But the project **is not likely to adversely affect** *[name of species]* because . . .
    Provide rationale for this effect determination.

    (*or*)

  - ◻ And the project **is likely to adversely affect** *[name of proposed species]* because . . .
    Provide rationale for this effect determination.

- The jeopardy call language for proposed species is **will** or **will not jeopardize the continued existence** of *[name of proposed species]*.

- A jeopardy call is made at the species level, not the individual level. Jeopardy occurs when an action reduces the likelihood of both the survival and recovery of a listed species in the wild by reducing reproduction, numbers, or distribution of that species. (Impacts on individuals but not on the survival of the species as a whole do not warrant a jeopardy call.) Projects that receive a jeopardy call are not likely to be constructed.

- The provisional effect determination for proposed species can be NE, NLTAA, or LTAA, as explained above for listed species.

- Effect determination language to use for proposed critical habitat:

  - ◻ The project **will not destroy or adversely modify** proposed *[name of proposed critical habitat]* critical habitat because . . .
    Provide rationale for adverse modification call.

  - ◻ If *[name of proposed critical habitat]* is designated prior to completion of this project, a provisional effect determination for critical habitat is provided:
    The project will have **no effect** on *(name of proposed critical habitat*) because . . .
    Provide rationale for this effect determination.

  - ◻ The project **may affect** *[name of proposed critical habitat]* because . . .
    Provide reasons why critical habitat may be affected.

- ◻ But the project **is not likely to adversely affect** *[name of proposed critical habitat]* because . . .
  Provide rationale for this effect determination.

  (*or*)

- ◻ And the project **is likely to adversely affect** *[name of proposed critical habitat]* because . . .
  Provide rationale for this effect determination.

- The adverse modification language for proposed critical habitat is **will** or **will not destroy or adversely modify** proposed *[name of proposed critical habitat].*

- An adverse modification call is made for a species' critical habitat as a whole. Adverse modification of critical habitat is not allowed under the ESA and occurs when the functionality of the habitat or of the primary constituent elements is changed to such an extent that the habitat no longer serves the intended conservation role for the species.

- The provisional effect determination can be NE, NLTAA, or LTAA, as explained above for designated critical habitats.

This chapter provides guidance for making effect determinations for species and habitat. Common flaws in making effect determinations are discussed, as are issues of debate. Flowcharts are provided to illustrate the effect determination process for terrestrial species and critical habitat. BA writing samples are included to show examples of effectively written effect determinations.

12.1 Common Flaws in Making Effect Determinations

The preamble to the ESA Section 7 regulations states that projects found to have beneficial, insignificant, or discountable effects on listed species may be approved by the Services through the informal consultation process. Service approval is contingent upon the BA (or BE) providing an adequate justification for the effect determination. The Services cannot concur with an effect determination without adequate supporting information. Insufficient supporting material often delays the informal consultation process.

Frequently, a BA concludes with effect determinations that may not be wrong but simply are not justified with supporting evidence and rationale in the BA. The BA should lead the reviewer through a discussion of effects to a logical, well-supported conclusion.

For example, certain arguments might justify a NLTAA determination but do not support the often-chosen NE determination. A NE determination means that there will be absolutely no effect, not that a small effect will occur or that an effect is unlikely to occur. If effects are insignificant (in size) or discountable (meaning they are extremely unlikely to occur), a NLTAA determination is probably appropriate. An action that results in only beneficial effects on a particular species does not qualify for a NE determination; rather, a NLTAA determination is appropriate.

Three types of inappropriate arguments commonly used in BAs to support effect determinations are discussed below in an excerpt adapted from *Biological Assessment Preparation and Review,* proceedings of a 1993 workshop (updated in 1998) sponsored by the USFWS; Resources Northwest, Inc.; and the Washington chapter of the Wildlife Society.

The Displacement Approach

This relates to the argument that removal of habitat or disturbance of individuals warrants a NLTAA or NE determination because individuals can simply go elsewhere. Except for wide-ranging species such as grizzly bears and gray wolves, this argument is usually unacceptable. When the argument is used, some rationale must be provided to indicate that adequate refugia are available and the impact will not occur during denning or nesting periods. In any case, a *no-effect* call in these situations is usually inappropriate. The species will be affected but, depending on the situation, perhaps not adversely so.

The Not-Known-to-Occur-Here Approach

Stating that the species is *not known to occur here* suggests that no surveys—or inadequate surveys—cover the area. Unless adequate surveys have been conducted or adequate information sources have been referenced, the “not known” statement is difficult to interpret. It raises the questions *Have you looked?* and *How have you looked?*

Rather than “not known,” the operative phrase is “known not.” A determination of NE or NLTAA must pass a *known-not-to-occur-here* test. The BA must show that the species is *known not to occur here*.

Always reference information sources. Have you queried the Washington Department of Fish and Wildlife's Priority Habitats and Species database, for example? Species occurrence information that is generated through one day/year surveys or wildlife observation cards (which more closely reflect the location of people, for example) are usually inadequate to justify species absence. In situations where wide-ranging species are difficult to census (e.g., grizzly bear and gray wolf), it is advisable to assume species presence if the habitat is present.

The timing of surveys is also important. Consider the life history of the species when scheduling surveys. Many plants are only identifiable while flowering, for example.

An example of making an inappropriate effect determination based upon the assumption that a species is "not known to occur here" is a no-effect determination for bull trout within Lake Washington. Bull trout have access to and have been historically documented in Lake Washington; however, their occurrence in the lake is so rare that it is unlikely they would be exposed to impacts associated with in-water work in the Lake Washington system. When potential impacts are considered discountable rather than impossible, as in this example, an effect determination of NLTAA, rather than NE, is appropriate.

The Leap-of-Faith Approach

The leap-of-faith approach refers to the assumption of some project biologists that the Services reviewer is familiar with the project and its location, so that there is no need to fully explain the impact the project may have on listed species. There is little or no connection or rationale provided to lead the reader from the project description to the effect determination. Reviewers cannot assume conditions that are not presented in the BA. A BA that contains such assumptions leaves both the project proponent and the Services at risk of being challenged by third parties who do not necessarily share in or trust the good working relationship between the Services and project biologists.

12.2 Determinations for Species

The process for making an effect determination is illustrated in the flowchart presented in Figure 12-1. Figure 12-1 illustrates this process for terrestrial species.

12.2.1 Effect Determinations for Listed Species

When the process of assessing project impacts upon each species is completed, one of three effect determinations must be made: NE, NLTAA, or LTAA. The Effects Analysis section of the BA must provide sufficient information to substantiate the effect determination. Often a project biologist summarizes the impacts to support the effect determination, as illustrated in the effect determination language examples below.

12.2.1.1 No Effect Determinations for Listed Species

If a project will have no effect whatsoever (not a minimal effect or a long-term beneficial effect) on a listed species, a NE determination is appropriate. NE means no effect whatsoever, including no beneficial, highly improbable, or insignificant effects will result from the project. An example of this language is provided below for a listed species:

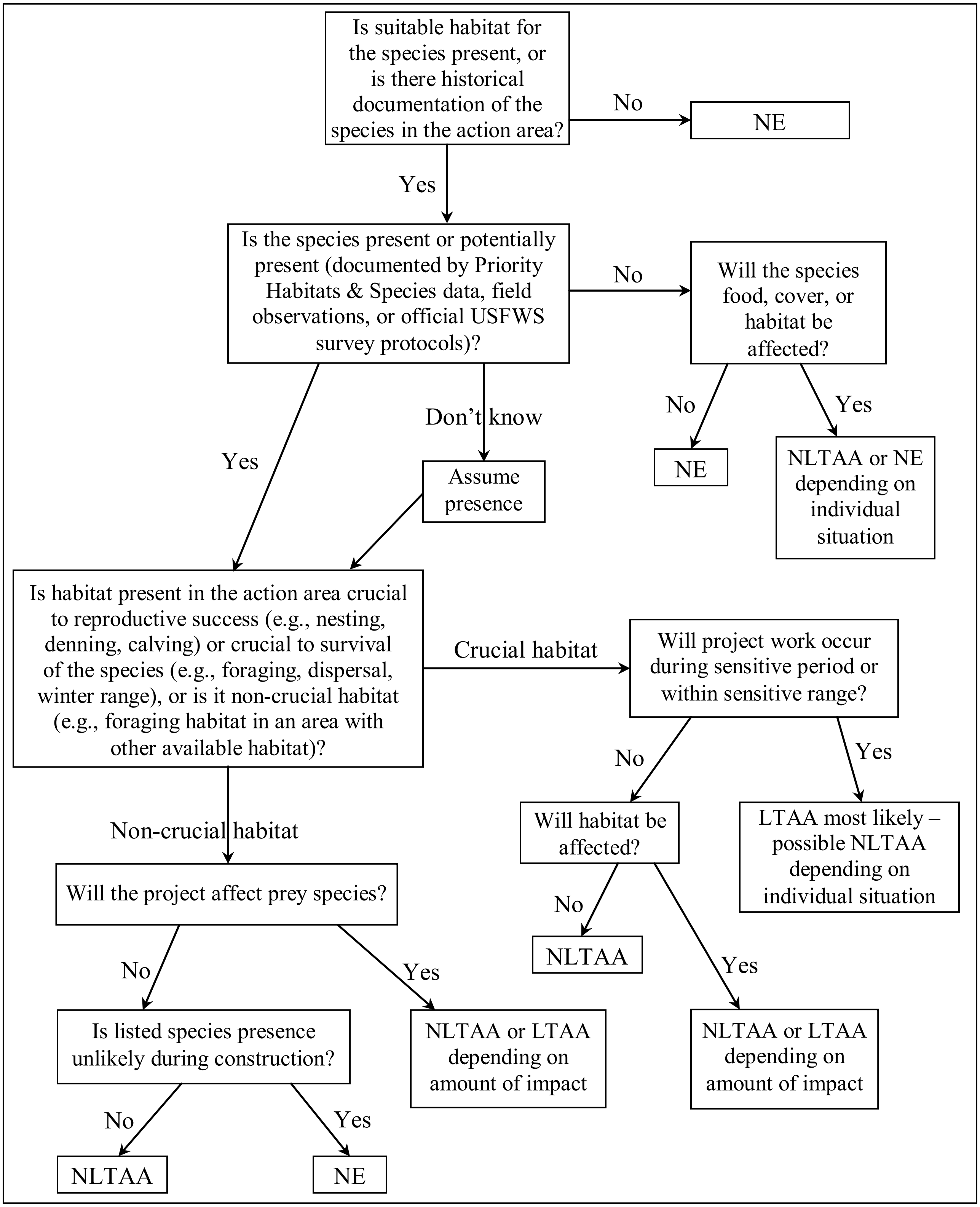

Figure 12-1. Making effect determinations for terrestrial species.

Northern spotted owl: No effect.

The project will have **no effect** on northern spotted owls because:

- No suitable nesting habitat occurs in the project action area.
- The nearest breeding occurrence is more than 6 miles away.
- Habitat present in the vicinity of the project is not suitable for foraging or dispersal.

12.2.1.2 May Affect, Not Likely to Adversely Affect Determinations for Listed Species

If direct and indirect effects from a federal project (including any interrelated and interdependent activities) are expected to be discountable, insignificant, or completely beneficial, the appropriate conclusion is NLTAA for listed species. *Insignificant* indicates that the impact of an action never reaches the level where *take* occurs or where adverse modification of critical habitat occurs. *Discountable* indicates that it is extremely unlikely that impacts will occur.

A USFWS example of this NLTAA language is provided below for a listed species:

> The project may affect but is not likely to adversely affect bull trout. A *may-affect* determination is warranted because the project involves ground-disturbing activities in a water body that may support bull trout, and it is upstream of forage fish habitat. A *not likely to adversely affect* determination is warranted, because bull trout are not expected to be present during construction, and because sediment from the project is not expected to reach the forage fish spawning habitat.

Two additional examples of NLTAA language are provided below for listed species.

Example 1:

The project **may affect** marbled murrelet because:

- Suitable habitat is available in the mature spruce forest in the westernmost portion of the action area.
- Noise disturbance from construction activities will be audible within a portion of the marbled murrelet suitable habitat.

The project is **not likely to adversely affect** the marbled murrelet because:

- A survey of the area in 1997 resulted in no marbled murrelet detections. It is unlikely that marbled murrelets will be exposed to the project activities.
- No marbled murrelet suitable habitat will be removed as a result of this project.

- The potential marbled murrelet suitable habitat (greater than 150 meters from the project site) is outside the distances associated with project activity injury thresholds (less than 75 meters for high-action-generated noises).

Example 2:

The project **may affect** Columbian white-tailed deer because:

- Suitable deer foraging habitat is present within the action area.
- Suitable habitat will be removed within the new roadway corridor and will be altered with establishment of the proposed waste site.

The project is **not likely to adversely affect** the Columbian white-tailed deer because:

- The only known populations of Columbian white-tailed deer in Washington state are located within the Julia Butler Hansen National Wildlife Refuge, and on Puget and Crims islands within the Columbia River corridor. The nearest of these populations is located more than 12 miles east and south of the project site. It is highly unlikely that Columbian white-tailed deer will be exposed to project activities.

12.2.1.3 May Affect, Likely to Adversely Affect Determinations for Listed Species

If any adverse effect on listed species may occur as a direct or indirect result of a project (including any interrelated or interdependent actions), and these effects are not discountable, insignificant, or completely beneficial, the appropriate conclusion or effect determination for a proposed action is LTAA. If the overall effect of the proposed action is beneficial to the listed species (or its designated critical habitat) but is also likely to cause some adverse effects, even in the short term, then the project merits an LTAA determination for listed species and critical habitat.

If incidental *take* is anticipated to occur as a result of the proposed action, an LTAA determination must be made. An LTAA determination requires formal consultation with the Services. An effect determination is made at the individual level rather than the species level (i.e., the determination is based on impacts on individual members of the species, even when survival of the species as a whole is not affected). An example of language for a project that will adversely affect listed species is provided below:

The project **may affect** Puget Sound Chinook salmon because:

- Suitable Chinook rearing habitat is present within the action area.
- Suitable rearing habitat will be destroyed as a result of the project.
- Water quality will be temporarily degraded as a result of in-water work.

The project is **likely to adversely affect** Puget Sound Chinook salmon because:

- Chinook salmon are known to rear in the immediate vicinity of the bridge site during the time of year when project activities will occur.
- Construction of the bridge will require placement of four large (6-foot-diameter) concrete piles in the canal.
- The old bridge may or may not be removed. If it is removed, the removal will have a long-term beneficial effect on water quality, but will have short-term adverse impacts on water quality due to suspension of sediments and potential resuspension of creosote.

12.2.2 Effect Determinations for Proposed Species

For proposed species that are addressed in the BA, the project biologist should provide a summary of the Analysis of Effects section. The BA should then provide the appropriate jeopardy determination for proposed species by concluding that the project is *likely to jeopardize the continued existence of the (name of species)*, or that the project *is not likely to jeopardize the continued existence of the (name of species)*. A jeopardy call is made at the species level, not the individual level.

> *Jeopardy – to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing reproduction, numbers, or distribution of that species. [50 CFR 402.02]*

The BA should also provide a conditional or provisional effect determination (NE, NLTAA, or LTAA) in the event that the species becomes listed prior to project completion. The rationale upon which this determination is made should be justified with a summary of relevant supporting evidence (e.g., specific information from field surveys agency coordination).

A project may be granted an incidental *take* permit for individuals, but not for a species as a whole, unless approved by the Endangered Species Committee. The role of the Endangered Species Committee and its process is discussed in detail in the DETERMINATIONS FOR CRITICAL HABITAT section below. A statement acknowledging the impact of the proposed action upon individuals also may be included.

An example of the language that may be used in the jeopardy determination is provided below:

The project **will not jeopardize the continued existence** of proposed Lower Columbia River coho because:

- Impacts on migrating spawning adults will not be sufficient to preclude both the survival and recovery of the ESU as a whole.
- Baseline conditions of the river will be maintained.

- However, if Lower Columbia River coho becomes listed prior to completion of the project, a provisional effect determination is provided below.

The project **may affect** Lower Columbia River coho because:

- Suitable migration, spawning, and rearing habitat is present within the action area.
- In-water work will occur within Grays River.

The project **is likely to adversely affect** Lower Columbia River coho because:

- Spawning adult coho migrating through the action area during project construction are likely to be disturbed by project activities.

12.3 Determinations for Critical Habitat

A statement summarizing anticipated impacts related to project actions must also be made for designated and proposed critical habitat in the project action area. Designated and proposed critical habitat must be addressed in the BA in order to meet ESA requirements.

The process by which a project biologist should make an effect determination for critical habitat is illustrated in Figure 12-2.

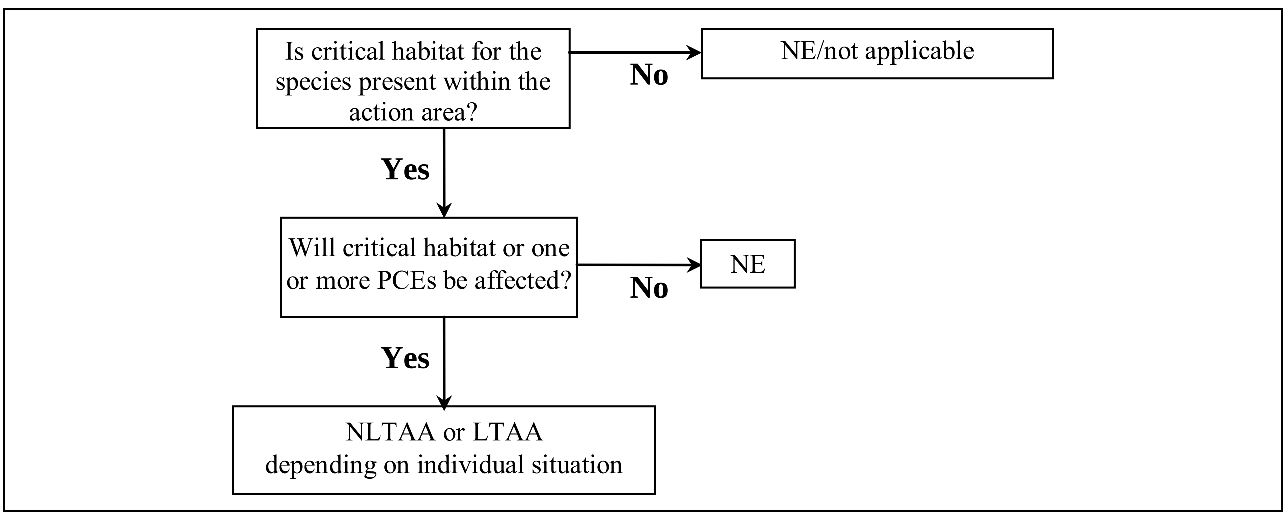

Figure 12-2. Making effect determinations for critical habitat.

The effect determination for critical habitat is one of the three standard determination categories: NE, NLTAA, or LTAA. The NLTAA determination is appropriate for projects that will have insignificant, discountable or entirely beneficial impacts upon critical habitat. This determination

(NLTAA) will result in informal consultation. Projects meriting a LTAA determination for critical habitat require formal consultation.

For species such as salmon, steelhead, bull trout, and Canada lynx, the rationale upon which the critical habitat effect determination is made should reference the primary constituent elements that may be affected and why they may or may not be adversely affected, and should justify the effect determination with a summary of relevant supporting evidence (e.g., information from field surveys and agency coordination). For example, if the critical habitat present contains six PCEs and only three PCEs may be affected by the project, then the effects of the action on each of the three PCEs should be clearly stated in the rationale.

For a no effect determination, none of the PCEs would be impacted by the project. Projects potentially affecting one or more PCEs will fall in a NLTAA or LTAA category for critical habitat. If anticipated impacts are insignificant, discountable or entirely beneficial, NLTAA is the appropriate determination. Projects anticipating adverse impacts to any PCE will result in a LTAA determination for critical habitat. An example letter providing NMFS critical habitat analysis/concurrence for a NLTAA Corps of Engineers project is provided on the Reference CD accompanying this manual. For other species such as northern spotted owl and marbled murrelet, an effect to critical habitat can result even if none of the primary constituent elements are affected. In the example in Section 12.3.1.2, unsuitable habitat is being altered, however, the alteration will not impact the primary constituent elements of northern spotted owl critical habitat or compromise the conservation role of the habitat for northern spotted owl.

Based on the effect determination and the information provided in the BA, the Services must determine if the project action will destroy or adversely modify designated critical habitat. Adverse modification to critical habitat occurs when the habitat characteristics or the necessary habitat elements are changed to such an extent that the habitat no longer serves the intended conservation role for the species.

A LTAA effect determination by a project biologist for critical habitat within the project action area may or may not merit an adverse modification call by the Services. The formal responsibility for making an adverse modification call on designated critical habitat rests with the Services. NMFS has developed guidance regarding the application of the "destruction or adverse modification" standard under Section 7(a)(2) of the ESA. The guidance instructs biologists to avoid referencing or using the regulatory definition provided in 50 CFR 402.02, which appears below:

> *Destruction or Adverse Modification – A direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical. [50 CFR 402.02]*

Instead, the guidance instructs biologists to consider the statutory concepts embodies in Sections 3 (the definitions of critical habitat and conservation), 4 (the procedures for delineating and adjusting areas included in a designation, and 7 (the substantive standard in paragraph (a)(2) and the procedures in paragraph (b)).

This guidance letter, outlines the process NMFS biologists are to follow in making an adverse modification call to critical habitat. This process is summarized below:

- Discuss the entire critical habitat area in terms of the biological and physical features that are essential to the conservation of the species. More specifically: Identify and discuss the primary constituent elements (PCEs) of the critical habitat, the current condition, the factors responsible for that condition.

- Describe the conservation role of individual critical habitat units, primary constituent elements, and/or areas identified as essential to the conservation of the species.

- For critical habitat designations that pre-date the requirement for identification of PCEs, the best available scientific and commercial data should be used to determine these elements or habitat qualities.

- Conservation is defined in Section 3 of the ESA as:

The terms "conserve," "conserving," and "conservation" mean to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking.

- Conservation activities outside of critical habitat should not be considered when evaluating effects to critical habitat.

- Discuss the relationship of the affected units or specific areas in the action area to the entire designated or proposed critical habitat with respect to conservation of the listed species, unless the final rule designating critical habitat has already done so.

- Characterize the direct and indirect effects of the action and those of interrelated and interdependent actions on the proposed or designated critical habitat. Describe how the PCEs or habitat elements essential to the conservation of the species are likely to be affected and how that will influence the function and conservation role of the affected critical habitat units or areas.

- If cumulative effects are being considered, the analysis should focus on how the function and conservation role of critical habitat units or areas will be affected.
- In concluding this analysis, discuss whether critical habitat (or PCEs) would remain functional to serve the intended conservation role for the species.

To facilitate the Services assessment, or as a courtesy to the Services, the action agency may choose to provide a provisional adverse modification call in its BA accompanying the effect determination. The guidance summarized above should be followed when completing this adverse modification evaluation.

A project determined by a Service biologist to adversely modify designated critical habitat, which is the equivalent of a jeopardy call for a listed species, cannot be conducted without modifications in accordance with a reasonable and prudent alternative (RPA) or permission from the Endangered Species Committee. As outlined in Section 7 of the ESA, an exemption to the statute can be granted only by applying to the Endangered Species Committee. This committee, composed of seven government officials including the secretary of the interior, is authorized to overrule the actions or decisions of the Services in order to grant relief from actions taken under the ESA. The committee has authority to decide that the public interest favors an action that has an adverse impact on a species (in its entirety) or results in the complete extirpation of a species.

The Endangered Species Committee is discussed below in the LTAA example provided for proposed critical habitat, as well as in the text of the ESA, which is provided on the reference compact disc accompanying this document.

12.3.1 Effect Determinations for Designated Critical Habitat

The project biologist must make an effect determination for each designated critical habitat occurring in the project action area. As indicated above, this determination consists of one of the three standard effect determinations: NE, NLTAA, or LTAA.

12.3.1.1 No Effect Determinations for Designated Critical Habitat

The text below provides an example of language that may be used for a *no effect* on designated critical habitat:

> A **no effect** determination is warranted for spotted owl critical habitat because:
>
> - The project does not occur within designated spotted owl critical habitat.

A second example appears below:

The project occurs within designated spotted owl critical habitat in the Gifford Pinchot National Forest. However, a **no effect** determination is warranted for spotted owl critical habitat because:

- Habitat within the action area is unsuitable for spotted owl nesting, dispersal or foraging.
- The project will not result in physical habitat impacts.
- Noise generated by the project will not exceed ambient conditions.
- None of the PCEs will be affected by the proposed project.

12.3.1.2 Not Likely To Adversely Affect Determinations for Designated Critical Habitat

The text below provides an example of language that may be used for a NLTAA project that occurs within designated critical habitat but does not affect suitable habitat or primary constituent elements:

A **may effect** determination is warranted for spotted owl critical habitat because:

- The project occurs within designated spotted owl critical habitat in the Gifford Pinchot National Forest.
- The project will result in habitat impacts within this designated critical habitat area because it requires vegetation removal (brush removal immediately adjacent to the roadway to maintain sight distance standards to improve safety).

A **not likely to adversely affect** determination is warranted for spotted owl critical habitat because:

- All vegetation that will be removed is directly adjacent to the highway within the right-of-way.
- The forested edge habitat on either side of the roadway right-of-way is unsuitable for nesting, foraging, and dispersal.
- Noise generated by the project will be elevated above ambient conditions within the unsuitable habitat area, but these noise levels will not extend to the suitable habitat located in the interior of the surrounding stands.

The text below provides a second example of NLTAA language for a project that lies within critical habitat. The potential for the project to impact the critical habitat is discountable:

A **may effect** determination is warranted for Snake River sockeye salmon critical habitat because:

- The project lies within designated critical habitat.

- The project crosses a stream that flows into this critical habitat.
- The following PCEs for critical habitat are present in the project action area: spawning, rearing, and migration

The project is **not likely to adversely affect** designated Snake River sockeye salmon critical habitat because:

- Proposed project activities will not add any additional impervious surface area or affect existing stormwater treatment BMPs or facilities.
- Although the project crosses a stream that flows to the Snake River, no in-water work will occur.
- Although construction vehicles may use existing pull-outs for parking during hours of construction and for temporary staging areas, all of these sites are more than 500 feet from the tributary stream, and no activity will extend beyond the developed portion of the roadway (zone 2).
- No clearing, grubbing, or ground-disturbing activity is included as part of the proposed action.

12.3.1.3 Likely To Adversely Affect Determinations for Designated Critical Habitat

The text below provides an example of language that may be used for a LTAA project that occurred within one designated critical habitat area and was located within 1 mile of a second designated critical habitat area:

A **may effect** determination is warranted for spotted owl critical habitat because:

- The project occurs within designated spotted owl critical habitat in the Gifford Pinchot National Forest.
- The project will result in habitat impacts within this designated critical habitat area because it requires the removal of 20 trees (10 of which are 6 to 10 inches in diameter at breast height, 10 of which are 36 or more inches in diameter at breast height).

A **likely to adversely affect** determination is warranted for spotted owl critical habitat because:

- Up to 10 suitable nesting trees will be removed.
- The nesting and roosting primary constituent elements will potentially be affected by the proposed project.

During formal consultation, if the Services determine that a project will adversely modify the designated critical habitat, the project warrants an adverse modification call from the Services. The project then cannot proceed without approval from the Endangered Species Committee. The project proponent must then submit to the secretaries of Interior and Commerce a petition to overrule standard ESA practices (or to overrule a decision made under the ESA by the Services that prevents project implementation). Upon receipt of the petition, these agencies are required to notify the governors of the affected states that the governors may recommend individuals to be appointed to the Endangered Species Committee. The Interior and Commerce secretaries also must publish receipt of the petition in the Federal Register.

Under the law, during the 20-day period following receipt of the petition, the secretaries must determine whether the project proponent has carried out in good faith its responsibilities under the ESA with a “reasonable and responsible effort to develop and fairly consider modifications or reasonable and prudent alternatives.” The secretaries also must determine whether the parties submitting the petition have met all legal requirements. Following these initial determinations, a public hearing must be held and a summary report must be submitted within 140 days. The full Endangered Species Committee must decide within 30 days whether to grant an ESA exemption.

12.3.2 Effect Determinations for Proposed Critical Habitat

For proposed critical habitat, the project biologist must conclude whether the proposed project actions would *adversely modify* this habitat. The project biologist must use the proper language when presenting this conclusion by specifically stating whether the action will or will not *destroy or adversely modify* designated critical habitat. The project biologist should substantiate this claim with a summary of relevant findings or documentation.

In addition, the project biologist should provide a conditional or provisional effect determination (NE, NLTAA, or LTAA), in the event that critical habitat is designated prior to initiation or completion of the project.

12.3.2.1 Will Not Destroy or Adversely Modify/Not Likely to Adversely Affect Determination for Proposed Critical Habitat

An example is provided below of *will not destroy or adversely modify* language for proposed critical habitat, followed by a provisional *may affect, not likely to adversely affect* determination. Please note, that this example involves an imaginary species due to the fact that at the time this manual was printed, no critical habitat was proposed, aside from the proposed redefinitions of marbled murrelet and northern spotted owl critical habitat.

> The project will not destroy or adversely modify proposed blue-footed flying squirrel critical habitat because:
>
> - Anticipated habitat impacts within this proposed critical habitat area will affect non-suitable habitat and will not affect any PCEs.
> - The conservation role of the habitat for the species will not be altered by the proposed project.
>
> If blue-footed flying squirrel critical habitat is designated prior to completion of this project, a provisional effect determination for critical habitat is the following:

The project **may affect but is not likely to adversely affect** blue-footed flying squirrel critical habitat.

A **may effect** determination is warranted for proposed blue-footed flying squirrel critical habitat because:

- The project will result in habitat impacts within the proposed critical habitat area because it requires the removal of 20 small trees (all of which are 6 to 10 inches in diameter at breast height, i.e., non-suitable habitat).

A **not likely to adversely affect** determination is warranted for blue-footed flying squirrel critical habitat because:

- All trees that will be removed are directly adjacent to the highway, and removal will not appreciably diminish the conservation value of the critical habitat.
- No suitable nesting trees will be removed.
- No primary constituent elements will be affected by the proposed project.

12.3.2.2 Will Not Adversely Modify/Likely to Adversely Affect Determination for Proposed Critical Habitat

An example of adverse modification language, a *likely to adversely affect* determination, and supporting evidence for proposed critical habitat are provided below. Please note that this example involves an imaginary species due to the fact that, at the time this manual was printed, no critical habitat was proposed, aside from the proposed redefinitions of marbled murrelet and northern spotted owl critical habitat.

The project will not destroy or adversely modify proposed blue-footed flying squirrel critical habitat because:

- Despite project impacts to ten potential nesting trees, impacts to habitat will not appreciably diminish the value of the critical habitat for conservation of the species because:
    - The trees to be removed are located on the perimeter of the stand
    - Changes to the size of the existing stand of suitable habitat will be insignificant
    - The existing stand's proximity and/or connection to other sizeable stands of suitable habitat will remain unchanged.

A **may effect** determination is warranted for blue-footed flying squirrel critical habitat because:

- The project occurs within blue-footed flying squirrel critical habitat in the Gifford Pinchot National Forest.

- The project will result in habitat impacts within this designated critical habitat area because it requires the removal of 20 trees (10 of which are 6 to 10 inches in diameter at breast height, 10 of which are 36 or more inches in diameter at breast height).

A **likely to adversely affect** determination is warranted for blue-footed flying squirrel critical habitat because:

- Up to 10 suitable nesting trees will be removed.
- The nesting primary constituent will potentially be affected by the proposed project.

During a formal conference, if the Services determine that a project will adversely modify the designated critical habitat, the project warrants an adverse modification call by the Services. The project then cannot proceed without approval of the Endangered Species Committee. This process is described above in the section titled EFFECT DETERMINATIONS FOR DESIGNATED CRITICAL HABITAT.

13.0 Effect Determination Guidance

Contents

Tables

13.0 Effect Determination Guidance

This chapter provides guidance for making overall effect determinations based on the effect determinations and rationale provided in the following three documents:

- *Programmatic Biological Assessment for the Washington State Department of Transportation Eastern Washington Regions – Working Document* (WSDOT 2004b)
- *No Effect and Not Likely to Adversely Affect Programmatic Biological Assessment Working Document for NOAA Fisheries Listed Species* (WSDOT 2002)
- *Biological Opinion and Letter of Concurrence of Effects on Bald Eagles, Marbled Murrelets, Northern Spotted Owls, Bull Trout, and Designated Critical Habitat for Marbled Murrelets and Northern Spotted Owls from Olympic National Forest Program Activities for August 5, 2003 to December 31, 2008* (USFWS 2003, Reference number 1-3-03-F-0833).

All three of the above-mentioned documents are programmatic BAs or relate to programmatic BAs that are used by their respective agencies (WSDOT and Olympic National Forest.) However, the effect determinations included in these documents can be used as guidance for making effect determinations in similar situations. Remember that effect determinations in programmatic BAs tend to be more conservative (i.e., more restrictive or protective) than effect determinations made on a project-by-project basis. Thus, for a given project it may be possible to reach a less conservative effect determination than the one given in the programmatic document, depending on the situation.

The first section of this chapter provides guidance for integrating multiple effect determinations for specific project elements into a single overall effect determination for each species addressed in the BA.

The second section of this chapter provides guidance for making effect determinations for species and critical habitats based on general standards and disturbance thresholds. This guidance is based on the definitions and criteria for *no effect* (NE), *not likely to adversely affect* (NLTAA), and *likely to adversely affect* (LTAA) determinations and the disturbance thresholds for species and critical habitat presented in the three documents listed above. The disturbance thresholds are based upon recent research regarding noise and visual disturbance. These thresholds can also serve as standards for making effect determinations.

It is important to note that the examples provided here apply to a specific suite of projects, species, and habitat types and do not necessarily apply to other WSDOT projects. The rationale and effect determinations provided here have been provided to help inform biologists preparing biological assessments what parameters or characteristics might be taken into consideration when making an effect determination.

13.1 Making Overall Effect Determinations

The biological assessment must provide a single effect determination, reflecting the impacts of the project as a whole, for each species and critical habitat. To do so, the project biologist must systematically consider all of the potential effects associated with various project elements in combination.

To facilitate the effects analysis, each of these project elements may first be evaluated individually, and effect determinations for each element may be developed. However, all of these elements and their associated effect determinations must subsequently be considered in combination to develop an overall effect determination for the project for each species or critical habitat. For a given species, the most stringent effect determination for any of the project elements (i.e LTAA vs. NLTAA) will be the overall project effect determination for the species. For example, if a project will have no effect on gray wolves for stormwater, in-water work and clearing and grading but will have a NLTAA for pile-driving, the overall project effect determination for that species would be NLTAA. In addition, the synergistic effects of an action must also be considered. For example, effects on temperature and dissolved oxygen when viewed separately might be considered minimal, but when viewed in concert, their synergistic effect on the physiological response of a fish may lead to a different overall conclusion.

One technique that can facilitate this process of determining overall project impacts is developing a worksheet that lists all affected species and all project elements, and the effect determinations associated with each. Although the worksheet should not be included in the BA, it can be a useful tool for ensuring that all anticipated project impacts are considered when making the overall effect determination for each species and critical habitat. An example of this type of worksheet is presented in Table 13-1.

13.2 Effect Determinations for Species

13.2.1 Effect Determinations for Listed Species

The following sections provide effect determination guidance for listed fish species under NOAA Fisheries and USFWS jurisdiction, followed by guidance tailored to fish, bird, small mammal, and plant species under USFWS jurisdiction.

13.2.1.1 Fish Species

NOAA Fisheries Listed Fish Species

For all of the fish species listed by NOAA Fisheries, as of 2002, effect determinations are compiled below, based on the nine program descriptions covered in the programmatic BA. Conditions for NE and NLTAA effect determinations are dependent upon the presence of listed fish species, proximity of activity to surface waters, level of disturbance, ability to contain activity within previously developed areas, use of appropriate BMPs, extent of riparian vegetation removal, work during appropriate work windows, and compliance with established guidelines, agreements, and permits. Although effect determinations are project-specific, the following conditions can serve as guidance in making effect determinations for other projects.

Table 13-1. Worksheet for determining overall effect determination for each affected species and critical habitat.

Regulatory Jurisdiction	Federal Status [a]	Common Name	Effect Determination for Stormwater Runoff	Effect Determination for In-Water Work	Effect Determination for Pile Driving	Effect Determination for Clearing and Grading	Overall Effect Determination for Project
USFWS	E	Gray wolf	NE	NE	NLTAA	NE	NLTAA
	E	Marsh sandwort	NE	NE	NLTAA	NLTAA	NLTAA
	T	Canada lynx	NE	NE	NLTAA	NE	NLTAA
	T	Grizzly bear	NE	NE	NLTAA	NE	NLTAA
	T	Marbled murrelet	NE	NE	LTAA	NLTAA	LTAA
	T	Northern spotted owl	NE	NE	LTAA	NLTAA	LTAA
	T	Coastal/Puget Sound bull trout (DPS)	NLTAA	LTAA	NLTAA	NLTAA	LTAA
	T	Water howellia	NLTAA	NE	NE	NE	NLTAA
	T	Golden paintbrush	NE	NLTAA	NLTAA	NLTAA	NLTAA
NOAA Fisheries	E	Humpback whale	NE	NE	NE	NE	NE
	E	Leatherback sea turtle	NE	NE	NE	NE	NE
	T	Steller sea lion	NE	NE	NE	NE	NE
	T	Puget Sound Chinook salmon (ESU)	NLTAA	LTAA	NLTAA	NLTAA	LTAA
	T	Hood Canal summer chum salmon (ESU)	NLTAA	LTAA	NLTAA	NLTAA	LTAA
	P	Southern resident killer whale (DPS)	NLTAA	NLTAA	NLTAA	NLTAA	LTAA

T = threatened; E = endangered; NE = no effect; LTAA = likely to adversely affect; NLTAA = not likely to adversely affect; DPS = distinct population segment; ESU = evolutionarily significant unit.

Many project types may warrant a determination of *no effect* on listed fish species. Examples of such projects include the following:

- Projects occurring in watersheds or water resource inventory areas (WRIAs) with no listed fish species
- Projects or maintenance activities that: 1) are conducted entirely within the developed transportation system right-of-way, 2) do not remove or modify vegetation in any way, 3) do not alter existing hydrology through modified discharges, and 4) do not discharge materials (such as water, asphalt grindings, or fill material) from the developed portion of the roadway

- Bridges undergoing seismic retrofit, bridge deck repair, or overlay and replacement, provided that they include no in-water work and create no additional impervious surface area.
- Projects where there are no listed species-bearing waters within the action area.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* listed fish species. Examples of such projects include the following:

- Projects that are located within 300 feet of an existing listed fish-bearing water's ordinary high water mark (OHWM) and that do not remove or alter riparian habitat.
- Projects for which best management practices (BMPs) are implemented to prevent sediments or runoff from entering surface water, and that do not permanently remove riparian vegetation greater than 6 inches in diameter at breast height (dbh) from a riparian area of a stream or river system containing listed salmonids.
- Projects in which slide material that has entered a listed fish-bearing water body will be removed within the appropriate work window when listed fish species are not likely to be present in the action area.
- Projects that require work below the OHWM to replace or extend culverts, provided that no ESA-listed salmonid species are present in the system during the approved work window, and that the work does not disturb spawning habitat. (Road crossing replacement culverts are to be designed in accordance with *Design of Road Culverts for Fish Passage* [WDFW 2003]. Tide gate replacement should use guidance in the *Programmatic Biological Opinion: Phase II Fish Passage Restoration, Department of Army Permits* [November 19, 2001].)
- Projects that relocate streams farther from the roadway or separate ditch or stream systems, provided that 1) listed salmonid species are not present in the system during construction, and 2) the activity restores or improves habitat functions that were provided by the original channel, through creation of meanders or vegetated stream banks, or installation of habitat structures.
- Projects that replace existing riprap structures with no expansion of the original footprint, based on the as-built plans, or projects that remove an equivalent amount of riprap within the project area during a period when listed fish species are not likely to be present.

USFWS Listed Fish Species

Bull trout is currently the only fish species listed by USFWS and covered in the WSDOT programmatic BA for eastern Washington. Conditions for NE, NLTAA, and LTAA effect determinations for bull trout depend upon bull trout presence, proximity of project activity to surface waters, bull trout use of the water body (spawning, rearing, or migration), level of disturbance, ability to contain activity within previously developed areas, use of appropriate BMPs, extent of riparian vegetation removal, and work within appropriate work windows. Projects located in bull trout spawning watersheds, which are very small headwater systems, are likely to have greater adverse effects and require more conservative effect determinations than projects located in watersheds used only for migration.

Examples of projects that may warrant a determination of *no effect* on bull trout include the following:

- Projects located in WRIAs that do not contain bull trout

- Projects that 1) are conducted entirely within the developed portion of the roadway, 2) do not remove or modify vegetation in any way, 3) do not alter existing hydrology through modified discharges, and 4) do not discharge materials (such as water or asphalt grinds) from the developed portion of the roadway.

Examples of projects that may warrant a determination of *may affect but is not likely to adversely affect* bull trout include the following:

- Activities located within 300 feet of a water body that supports bull trout or drains into a bull-trout-supporting water body and that 1) conduct work off the developed portion of the roadway, 2) do not expose soils, 3) do not create more than 150 square feet of impervious surface area, and 4) do not remove mature riparian vegetation. (This distance can be project-specific depending on factors such as topography, vegetation, habitat, or species use.)

- Activities located more than 300 feet from a water body that supports or drains into a bull-trout-supporting water body and that 1) are conducted within 100 feet of the existing transportation system, and 2) have BMPs implemented to prevent sediments or runoff from entering surface waters.

- Vegetation or ground-disturbing activities located within 100 to 300 feet of a water body that supports or drains into a bull-trout-supporting water body and that 1) are conducted within 100 feet of an existing transportation system, 2) remove no riparian vegetation greater than 6 inches dbh, and 3) implement a temporary erosion and sedimentation control (TESC) plan that is adequate to prevent sediment from entering surface water. (These distances can be project-specific depending on such factors as topography, vegetation, habitat, and species use.)

- Culvert and bridge widening, extension, repair, and replacement activities that 1) occur in waters where bull trout are unlikely to be present, 2) do not eliminate spawning habitat, 3) avoid constricting the system, 4) place less than 100 cubic yards of riprap, 5) are performed within the appropriate work window for bull trout as agreed upon by USFWS and WDFW, 6) remove less than 300 square feet of riparian vegetation, 7) use appropriate BMPs to control sedimentation, 8) revegetate disturbed vegetation, and 9) do not affect bull trout migration.

Examples of projects that may warrant a determination of *may adversely affect* bull trout include the following:

- Environmental enhancement projects, such as correction of fish barriers, installation of culverts to improve fish passage, and installation of fish habitat enhancement projects.
- In-water work activities in water bodies where listed fishes are present, especially if dewatering or fish-moving activities are likely to occur.
- Bridge and culvert widening, extension, repair, and replacement activities that do not meet the conditions of a NLTAA determination.

13.2.1.2 Marbled Murrelet

Marbled murrelets are sensitive to human disturbance, especially during the nesting season. Loss of suitable nesting habitat is one of the primary threats to marbled murrelet survival. Effect determinations are highly dependent upon the proximity of project activity to potential nesting areas and foraging habitat, activity noise levels, removal of suitable nesting habitat, and project timing in relation to the nesting season.

Many project types may warrant a determination of *no effect* on marbled murrelets. Examples of such projects include the following:

- Any project located more than 55 miles from marine waters.
- Any project or activity (including blasting) conducted within or outside suitable marbled murrelet nesting habitat, but outside the murrelet breeding season (April 1 through September 15), that does not remove suitable nesting habitat.
- Any project or activity conducted more than 60 yards (1 mile for blasting) from suitable marbled murrelet nesting habitat.

- Blasting activities between September 16 and March 30 that do not remove suitable marbled murrelet nesting habitat.
- Blasting activities between August 6 and September 15 occurring more than 1 mile from suitable marbled murrelet habitat.
- Use of impact pile drivers, jackhammers, or rock drills between September 16 and March 30.
- Use of impact pile drivers, jackhammers, or rock drills between August 6 and September 15 occurring more than 60 yards from suitable marbled murrelet habitat.
- Use of large helicopter or aircraft between September 16 and March 30.
- Use of large helicopter or aircraft between August 6 and September 15 more than 1 mile from suitable marbled murrelet habitat.
- Use of helicopter or single-engine aircraft between September 16 and March 30.
- Use of helicopter or single-engine aircraft between August 6 and September 15 more than 120 yards from suitable marbled murrelet habitat.
- Use of heavy equipment or motorized tools between September 16 and March 30 in the vicinity of suitable marbled murrelet habitat without affecting suitable habitat.
- Use of heavy equipment or motorized tools between August 6 and September 15 more than 35 yards from suitable marbled murrelet habitat without affecting suitable habitat.
- Use of chainsaws for felling trees and cutting downed wood between September 16 and March 30 without affecting suitable marbled murrelet habitat.
- Use of chainsaws for felling trees and cutting downed wood between August 6 and September 15 more than 45 yards from suitable marbled murrelet habitat.
- Any prescribed burning activities between September 16 and March 30.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* marbled murrelets. Examples of such projects include the following:

- Activities conducted between April 1 and September 15 within 0.25 miles of suitable marbled murrelet nesting habitat, without producing noise above ambient levels or removing or disturbing suitable habitat.
- Activities (with the exception of blasting) conducted within 0.25 miles of suitable marbled murrelet nesting habitat, after August 5 and before September 15 between 2 hours after sunrise and 2 hours before sunset, or between September 15 and April 1, that result in increased human activity, disturbance, and noise above ambient levels but do not affect suitable habitat.
- Blasting activities between April 1 and August 5 occurring more than 1 mile from suitable marbled murrelet habitat.
- Blasting activities between August 6 and September 15 occurring less than 1 mile from suitable marbled murrelet habitat.
- Use of impact pile drivers, jackhammers, or rock drills between April 1 and August 5 more than 60 yards from suitable marbled murrelet habitat.
- Use of impact pile drivers, jackhammers, or rock drills between August 6 and September 15 less than 60 yards from suitable marbled murrelet habitat.
- Use of large helicopter or aircraft between April 1 and August 5 more than 1 mile from suitable marbled murrelet habitat.
- Use of large helicopter or aircraft between August 6 and September 15 less than 1 mile from suitable marbled murrelet habitat.
- Use of helicopter or single-engine aircraft between April 1 and August 5 more than 120 yards from suitable marbled murrelet habitat.
- Use of helicopter or single-engine aircraft between August 6 and September 15 less than 120 yards from suitable marbled murrelet habitat.
- Use of heavy equipment or motorized tools between April 1 and August 5 more than 35 yards from suitable marbled murrelet habitat.
- Use of heavy equipment or motorized tools between August 6 and September 15 less than 35 yards from suitable marbled murrelet habitat without affecting suitable habitat.
- Use of chainsaws for felling trees and cutting downed wood between April 1 and August 5 more than 45 yards from suitable marbled murrelet habitat.

- Use of chainsaws for felling trees and cutting downed wood between August 6 and September 15 less than 45 yards from suitable marbled murrelet habitat without affecting suitable habitat.
- Prescribed burning activities between April 1 and August 5 occurring more than 0.25 miles from suitable marbled murrelet habitat.
- Prescribed burning activities between August 6 and September 15 occurring less than 0.25 miles from suitable marbled murrelet habitat.

Examples of project types that may warrant a determination of *likely to adversely affect* marbled murrelets include the following:

- Blasting activities between April 1 and August 5 occurring less than 1 mile from suitable marbled murrelet habitat.
- Use of impact pile driver, jackhammer, or rock drill between April 1 and August 5 less than 60 yards from suitable marbled murrelet habitat.
- Use of large helicopter or aircraft between April 1 and August 5 less than 1 mile from suitable marbled murrelet habitat.
- Use of helicopter or single-engine aircraft between April 1 and August 5 less than 120 yards from suitable marbled murrelet habitat.
- Use of heavy equipment or motorized tools between April 1 and August 5 less than 35 yards from suitable marbled murrelet habitat.
- Use of chainsaws for felling trees and cutting downed wood between April 1 and August 5 less than 45 yards from suitable marbled murrelet habitat.
- Prescribed burning activities between April 1 and August 5 occurring less than 0.25 miles from suitable marbled murrelet habitat.
- Removal of suitable marbled murrelet nesting habitat, including trees with suitable nesting platforms.

13.2.1.3 Northern Spotted Owl

Projects that involve clearing of mature coniferous forest could adversely affect spotted owl habitat. Loss of suitable nesting habitat is one of the primary threats to spotted owl survival. Conditions for NE and NLTAA effect determinations depend upon proximity of the project activity to nesting habitat, activity noise levels, modification of suitable habitat, and timing of activity in relation to the nesting season.

Many project types may warrant a determination of *no effect* on spotted owls. Examples of such projects include the following:

- Activities conducted in counties that do not contain suitable spotted owl habitat.
- Activities conducted both outside the spotted owl breeding season (March 1 to September 30) and outside suitable habitat.
- Activities conducted at any time within suitable spotted owl habitat that 1) produce noise at or below ambient noise levels, 2) produce human disturbance levels at or below normal, and 3) do not modify suitable habitat.
- Activities that do not modify suitable spotted owl habitat, conducted at any time, where all suitable habitat within 0.25 miles of the project (1 mile for blasting) has been surveyed to protocol and no spotted owl activity centers have been located.
- Any blasting activities between October 1 and February 28.
- Blasting activities between July 16 and September 30 occurring more than 1 mile from suitable spotted owl habitat.
- Use of impact pile drivers, jackhammers, or rock drills between October 1 and February 28.
- Use of impact pile drivers, jackhammers, or rock drills between July 16 and September 30 more than 60 yards from suitable spotted owl habitat.
- Use of large helicopter or aircraft between October 1 and February 28.
- Use of large helicopter or aircraft between July 16 and September 30 more than 1 mile from suitable spotted owl habitat.
- Use of helicopter or single-engine aircraft between October 1 and February 28.
- Use of helicopter or single-engine aircraft between July 16 and September 30 more than 120 yards from suitable spotted owl habitat.
- Use of heavy equipment or motorized tools between October 1 and February 28.

- Use of heavy equipment or motorized tools between July 16 and September 30 more than 35 yards from suitable spotted owl habitat.

- Use of chainsaws for felling trees and cutting downed wood between October 1 and February 28.

- Use of chainsaws for felling trees and cutting downed wood between July 16 and September 30 more than 65 yards from suitable spotted owl habitat.

- Prescribed burning activities between October 1 and February 28 occurring more than 0.25 miles from suitable spotted owl habitat.

It is assumed that suitable spotted owl habitat would not be modified as a result of the conditions listed above.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* spotted owls. Examples of such projects include the following:

- Noise-generating construction activities (excluding blasting) conducted during the spotted owl breeding season (March 1 through September 30) more than 0.25 miles from known spotted owl activity centers without modifying suitable habitat.

- Noise-generating construction activities (excluding blasting) conducted outside the spotted owl breeding season (October 1 to February 28) but within suitable habitat, without modifying suitable habitat.

- Activities that produce noise above ambient levels, conducted during the early breeding season (March 1 to July 15), within 0.25 miles of known spotted owl activity centers that are nonnesting for the year, without modifying suitable habitat.

- Blasting activities between March 1 and July 15 occurring more than 1 mile from suitable spotted owl habitat.

- Blasting activities between July 16 and September 30 occurring less than 1 mile from suitable spotted owl habitat.

- Use of impact pile drivers, jackhammers, or rock drills between March 1 and July 15 more than 60 yards from suitable spotted owl habitat.

- Use of impact pile drivers, jackhammers, or rock drills between July 16 and September 30 less than 60 yards from suitable spotted owl habitat.

- Use of large helicopter or aircraft between March 1 and July 15 more than 1 mile from suitable spotted owl habitat.

- Use of large helicopter or aircraft between July 16 and September 30 less than 1 mile from suitable spotted owl habitat.

- Use of helicopter or single-engine aircraft between March 1 and July 15 more than 120 yards from suitable spotted owl habitat.

- Use of helicopter or single-engine aircraft between July 16 and September 30 less than 120 yards from suitable spotted owl habitat.

- Use of heavy equipment or motorized tools between March 1 and July 15 more than 35 yards from suitable spotted owl habitat.

- Use of heavy equipment or motorized tools between July 16 and September 30 less than 35 yards from suitable spotted owl habitat.

- Use of chainsaws for felling trees and cutting downed wood between March 1 and July 15 more than 65 yards from suitable spotted owl habitat.

- Use of chainsaws for felling trees and cutting downed wood between July 16 and September 30 less than 65 yards from suitable spotted owl habitat.

- Prescribed burning activities between March 1 and July 15 occurring more than 0.25 miles from suitable spotted owl habitat.

- Prescribed burning activities between July 16 and September 30 occurring less than 0.25 miles from suitable spotted owl habitat.

It is assumed that suitable owl habitat would not be modified as a result of most of the conditions listed above.

Examples of project types that may warrant a determination of *likely to adversely affect* northern spotted owls include the following:

- Blasting activities conducted between March 1 and July 15 less than 1 mile from suitable spotted owl habitat.

- Use of impact pile drivers, jackhammers, or rock drills between March 1 and July 15 less than 60 yards from suitable spotted owl habitat.

- Use of large helicopter or aircraft between March 1 and July 15 less than 1 mile from suitable spotted owl habitat.

- Use of helicopter or single-engine aircraft between March 1 and July 15 less than 120 yards from suitable spotted owl habitat.
- Use of heavy equipment or motorized tools between March 1 and July 15 less than 35 yards from suitable spotted owl habitat.
- Use of chainsaws for felling trees and cutting downed wood between March 1 and July 15 less than 65 yards from suitable spotted owl habitat.
- Prescribed burning activities between March 1 and July 15 occurring less than 0.25 miles from suitable spotted owl habitat.

13.2.1.4 Gray Wolf

Wolves are considered most sensitive to disturbance at their den and rendezvous sites. Effect determinations depend upon the proximity of project activities to den and rendezvous sites, activity noise level, modification of suitable habitat, and timing of the activity in relation to critical time periods (e.g., the calving period).

Examples of project types that may warrant a determination of *no effect* on gray wolves include the following:

- All projects located outside suitable gray wolf habitat.
- Projects located within Yakima, Kittitas, Chelan, Okanogan, Ferry, Stevens, Spokane, Asotin, Columbia, Garfield, Walla Walla, and Pend Oreille counties that do not involve clearing of native vegetation and will not produce noise above ambient levels.
- All projects located within the developed limits of a city or town in Kittitas, Yakima, Chelan, Okanogan, Ferry, Stevens, Spokane, Asotin, Columbia, Garfield, Walla Walla, and Pend Oreille counties.

Examples of project types that may warrant a determination of *may affect but is not likely to adversely affect* gray wolves include the following:

- Activities generating noise above ambient levels within 0.5 miles of a known gray wolf den or rendezvous site outside the critical denning and rendezvous period (between July 1 and March 14).
- Activities conducted within a known gray wolf territory in occupied ungulate calving, fawning, or kidding grounds, generating noise above ambient levels (or otherwise creating disturbance within occupied ungulate wintering areas), outside the wintering period (between April 16

and November 30) and outside the calving period (between June 16 and November 30).

- Activities conducted within 0.25 miles of an active, developed transportation corridor outside known, occupied wolf territories and occupied ungulate calving, fawning, or kidding grounds.

- Activities that occur within 0.5 miles of a known gray wolf den or rendezvous site without generating noise above ambient levels.

- Activities (excluding blasting and pile driving) that occur within 300 feet of a developed transportation corridor.

13.2.1.5 Woodland Caribou

Habitat loss and fragmentation, mortality associated with human activities, and natural predation are the greatest threats to woodland caribou in Washington. Effect determinations are dependent upon proximity of project activity to the known range of caribou, suitable habitat, or documented habitat.

Examples of project types that may warrant a determination of *no effect* on woodland caribou include the following:

- Projects located outside Pend Oreille and Stevens counties.

- Projects located in Pend Oreille and Stevens counties within the developed limits of a city or town.

- Projects located outside suitable or documented woodland caribou habitat.

13.2.1.6 Pygmy Rabbit

The primary cause of decline of the pygmy rabbit is loss of thick sagebrush habitat. The rabbit's dependency on a long-lived, slow-recovering food source (i.e., sagebrush) limits the potential for its rapid recovery. Effect determinations depend upon proximity of project activity to the known range of the pygmy rabbit and removal of suitable habitat.

Examples of project types that may warrant a determination of *no effect* on the pygmy rabbit include the following:

- Projects occurring outside Douglas County or Grant County.

- Projects occurring within Douglas County or Grant County but outside the present range of the pygmy rabbit.

- Projects occurring within the developed portion of the WSDOT right-of-way.
- Projects that do not involve removal of sagebrush or ground-disturbing activities within native shrub-steppe habitat.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* the pygmy rabbit. An example follows:

- Projects located in Douglas County or Grant County within the WSDOT right-of-way, requiring removal of sagebrush, provided that the habitat outside the right-of-way is agricultural or developed.

13.2.1.7 Grizzly Bear

Projects located in the North Cascades, Okanogan Highlands, and Selkirk Mountains are most likely to encounter grizzly bears. Along existing developed transportation corridors, which are not considered high-quality grizzly bear habitat, project impacts on habitat typically are negligible. Effect determinations depend upon proximity of project activity to the known potential range of grizzly bear, activity noise levels, removal of native vegetation, and proximity of the activity to developed transportation corridors.

Examples of project types that may warrant a determination of *no effect* on grizzly bears include the following:

- Projects located outside counties known to support grizzly bear habitat.
- Projects located in counties containing grizzly bear habitat that do not involve clearing of native vegetation and will not produce noise above ambient levels.
- Projects located within the developed city limits of a town in counties known to support grizzly bear habitat.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* grizzly bears. An example follows:

- Projects located within 0.25 miles of an active, developed transportation corridor within suitable grizzly bear habitat, provided that the habitat is not disturbed.

13.2.1.8 Wenatchee Mountains Checker-Mallow

Projects that involve ground-disturbing activities in wetland and riparian areas located in the Wenatchee Mountains could affect the Wenatchee Mountains checker-mallow. Effect determinations depend upon proximity of project activity to the known range of the Wenatchee Mountains checker-mallow and to wetlands, riparian areas, and suitable habitat.

Many project types may warrant a determination of *no effect* on Wenatchee Mountains checker-mallow. Examples of such projects include the following:

- Projects located outside Kittitas and Chelan counties.
- Projects located in Chelan and Kittitas counties that involve no ground-disturbing activities or are confined within the developed portion of the roadway.
- Projects located in Chelan and Kittitas counties but not in the Wenatchee Mountains and not between 1,600 and 3,300 feet elevation.
- Projects that do not remove or modify vegetation within 200 feet of wetlands or riparian areas and do not alter wetland hydrology.
- Project areas that do not contain suitable Wenatchee Mountains checker-mallow habitat, as determined by a survey conducted by a qualified biologist between June 15 and July 31.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* Wenatchee Mountains checker-mallow. Examples of such projects include the following:

- Projects located in the Wenatchee Mountains between 1,600 and 3,300 feet elevation that alter vegetation within 61 meters (200 feet) of unsurveyed, potentially suitable Wenatchee Mountains checker-mallow habitat, but do not alter wetland or riparian vegetation or hydrology.
- Projects located in the Wenatchee Mountains between 1,600 and 3,300 feet elevation that alter potentially suitable Wenatchee Mountains checker-mallow habitat not containing Wenatchee Mountain checker-mallow, as documented by a survey conducted by a qualified biologist between June 15 and July 31.

13.2.1.9 Ute Ladies'-Tresses

Projects that involve ground-disturbing activities in wetland and riparian areas located in transition zones could affect Ute ladies'-tresses (*Spiranthes diluvialis*). Effect determinations depend upon proximity of project activity to wetlands, riparian areas, and suitable habitat.

Many project types may warrant a determination of *no effect* on Ute ladies'-tresses. Examples of such projects include the following:

- Projects that do not involve ground-disturbing activities.
- Projects that do not alter wetland hydrology and that do not remove or modify vegetation within 200 feet of wetlands or riparian areas suitable for supporting Ute ladies'-tresses, as identified by the project biologist.
- Projects located above 7,000 feet elevation.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* Ute ladies'-tresses. Examples of such projects include the following:

- Project areas that do not contain Ute ladies'-tresses, as determined by a survey conducted by a qualified biologist between July 15 and September 15.
- Project areas that do not contain Ute ladies'-tresses, as determined by a survey conducted by a qualified biologist between July 1 and September 15.
- Projects located between sea level and 7,000 feet elevation that alter vegetation within 200 feet of unsurveyed, potentially suitable Ute ladies'-tresses habitat, but do not alter wetland or riparian vegetation or hydrology.

13.2.1.10 Water Howellia

The most significant threats to water howellia (*Howellia aquatilis*) include changes in wetland hydrology, increases in weedy species, livestock grazing, and timber harvest on adjacent uplands (WDNR and USDI BLM 1999). Effect determinations depend upon proximity of project activity to the known range of water howellia and suitable wetland habitat.

Many project types may warrant a determination of *no effect* on water howellia. Examples of such projects include the following:

- Projects that do not involve ground-disturbing activities.
- Projects conducted entirely within the developed portion of the roadway that do not modify vegetation or hydrology in adjacent wetlands.
- Projects located above 2,300 feet elevation.
- Projects or activities involving the alteration of habitat not suitable to water howellia, as identified by the project biologist.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* water howellia. An example follows:

- Projects that disturb suitable habitat that does not contain water howellia, as determined by a survey conducted between May 25 and July 15 by a qualified biologist.

13.2.1.11 Spalding's Catchfly

Projects that involve ground-disturbing activities in native grasslands could affect Spalding's catchfly (*Silene spaldingii*). Effect determinations depend upon proximity of project activity to the known range of Spalding's catchfly and its suitable habitat.

Many project types may warrant a determination of *no effect* on Spalding's catchfly. Examples of such projects include the following:

- Projects that occur outside Adams, Asotin, Garfield, Lincoln, Spokane, and Whitman counties.
- Projects located within Adams, Asotin, Garfield, Lincoln, Spokane, and Whitman counties that do not involve ground-disturbing activities.
- Projects that do not remove or modify native grassland habitat located in Adams, Asotin, Garfield, Lincoln, Spokane, and Whitman counties.
- Project areas that do not contain Spalding's catchfly, as determined by a survey conducted by a qualified biologist between July 15 and August 31.

13.2.2 Effect Determinations for Proposed Species

Effect determinations for proposed species are addressed briefly in the previous chapter.

13.3 Effect Determinations for Critical Habitat

The following sections provide guidance for making effect determinations for critical habitat of NOAA Fisheries listed fish species and critical habitat of USFWS listed Wenatchee Mountain checker-mallow and northern spotted owl.

Effect determinations for critical habitat should provide information on the primary constituent elements (PCEs) affected, briefly describe how they will be affected, and explain how these impacts influence the overall effect determination for critical habitat.

13.3.1 NOAA Fisheries Listed Fish Species Critical Habitat

The following compilation of conditions for effect determinations was generated from all of the program descriptions in the NOAA Fisheries programmatic BA. Many of the conditions apply to more than one program description. Most of the conditions are identical to the conditions used to make effect determinations for listed fish species. Conditions for effect determinations depend upon numerous factors, including presence of critical habitat, presence of listed fish species, proximity of project activity to surface waters, level of disturbance, ability to contain project activity within previously developed areas, use of appropriate BMPs, extent of riparian vegetation removal, restriction of work to appropriate work windows, and compliance with established guidelines, agreements, and permits.

Many project types may warrant a determination of *no effect* on critical habitat. Examples of such projects include the following:

- Projects with action areas located outside critical habitat.
- Projects located within critical habitat that 1) are conducted entirely within the developed portion of the roadway, 2) do not remove or modify vegetation in any way, 3) do not alter existing hydrology through modified discharges, and 4) do not discharge materials (such as water, asphalt grindings, or fill material) from the developed portion of the roadway.
- Bridges undergoing seismic retrofit, bridge deck repair, overlays, or replacements, provided that they involve no in-water work and create no additional impervious surface area.
- Projects located where there are no listed species-bearing waters within the action area.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* critical habitat. Examples of such projects include the following:

- Projects located within 300 feet of the ordinary high water mark (OHWM) of a listed fish-bearing water that do not remove or alter riparian habitat.
- Projects in which slide material has entered a listed fish-bearing water body and, if removal is necessary, will be conducted within the appropriate work window when listed fishes are not likely to be present in the action area.
- Activities that involve work below the OHWM to replace or extend culverts, provided that there are no ESA-listed salmonid species present in the system during the approved work window. (Road crossing replacement culverts will be designed in accordance with *Fish Passage Design at Road*

Culverts: A Design Manual for Fish Passage at Road Crossings (WDFW 1999). Tide gate replacement projects should follow the guidance in the programmatic biological opinion: *Phase II Fish Passage Restoration, Department of Army Permits* [11/19/01]).

- Projects that relocate streams farther away from the roadway or separate ditch/stream systems, provided that listed salmonid species are not present in the system during construction, and the activity restores or improves habitat functions provided by the original channel through creation of meanders, vegetated stream banks, or installation of habitat structures.

- Projects that replace existing riprap structures with no expansion of the original footprint based on the as-built plans, or projects that remove an equivalent amount of riprap within the project area during a period when listed fish species are not likely to be present.

- Projects that use blasting as a method of removing slide materials, with the blast and the fallout of materials occurring outside the aquatic system, provided that the blasting occurs within the designated work windows if listed fishes are known to be present in the immediate vicinity (one-quarter mile) upstream and downstream.

- Floating bridge maintenance projects consisting of the repair or replacement of floating bridge cables or the removal of derelict fishing nets.

13.3.2 Wenatchee Mountains Checker-Mallow

Many project types may warrant a determination *of no effect* on designated critical habitat for the Wenatchee Mountains checker-mallow (*Sidalcea oregana* var. *calva*). Examples of such projects include the following:

- Projects located entirely within WSDOT right-of-way that do not alter the hydrology of critical habitat for the Wenatchee Mountains checker-mallow.

- Projects located outside WSDOT right-of-way and critical habitat that do not alter the hydrology of critical habitat for the Wenatchee Mountains checker-mallow.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* designated critical habitat for the Wenatchee Mountains checker-mallow. Examples of such projects include the following:

- Projects that may alter the hydrology of critical habitat for the Wenatchee Mountains checker-mallow but will not adversely affect primary constituent elements.

13.3.3 Northern Spotted Owl

Many project types may warrant a determination of *no effect* on spotted owl suitable or critical habitat. Examples of such projects include the following:

- Activities conducted in counties that are outside the range of the Northern Spotted Owl.
- Activities that occur outside designated spotted owl critical habitat or suitable habitat.
- Activities conducted within spotted owl critical habitat that do not modify or remove suitable owl habitat, habitat components, or constituent elements of the stand.

Many project types may warrant a determination of *may affect but is not likely to adversely affect* spotted owl suitable or critical habitat. Examples of such projects include the following:

- Activities that modify younger stands within areas designated as critical habitat and that are not likely to impede development of constituent elements. Habitat areas located on federal land (e.g., national forest or national park lands) or state or private lands covered by a HCP may be modified only if the removal is consistent with the requirements of those lands.
- Activities that result in short-term degradation of dispersal habitat but are not likely to adversely degrade its suitability as dispersal habitat. Habitat areas located on federal land (e.g., national forest or national park lands) or state or private lands covered by a HCP may be modified only if the removal is consistent with the requirements of those lands.
- Activities that involve minimal modification of less than 5 acres per region per year of dispersal habitat located within areas designated as critical habitat. Habitat areas located on federal land (e.g., national forest or national park lands) or state or private lands covered by a HCP may be modified only if the removal is consistent with the requirements of those lands.

Many project types may warrant a determination of *may adversely affect* spotted owl suitable or critical habitat. Examples of such projects include the following:

- Activities involving moderate modification of less than 5 acres per region, per year, of currently suitable habitat located within 100 feet of an existing developed transportation corridor, that may degrade the constituent elements, provided that such activity does not occur within 0.25 miles of known spotted owl activity centers or is conducted outside the breeding season (October 1 to February 28). Habitat areas located on federal land (e.g., national forest or national park lands) or state or private lands covered by a HCP may be modified only if the removal is consistent with the requirements of those lands.

14.0 In-Water Work

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14.0 In-Water Work

Chapter Summary

- Describe specific methods, materials, and techniques of in-water construction elements of the project.
- Describe the duration and logistics of proposed in-water work.
- Discuss the timing of in-water work in relation to the presence of different life stages of listed species within the project action area, and also in relation to the in-water work windows stipulated by the WDFW area habitat biologist or the hydraulic project approval (HPA).
- Quantify anticipated impacts associated with the proposed activities.
- Describe stream bypass and fish handling or exclusion methods, if applicable.
- Discuss the extent of potential direct and indirect effects of proposed actions on habitat and various life stages of fish species that are present.
- When assessing impacts, consider impact minimization measures and BMPs that will be implemented to minimize project impacts.
- See guidance at the end of this chapter for effect determination considerations; also see PART 2: EFFECT DETERMINATION GUIDANCE.

14.1 General Considerations

This chapter provides general guidance on how to approach the analysis of effects associated with in-water work, general information and resources for understanding in-water work issues and activities, and specific guidance for making effect determinations pertaining to in-water work.

Frequently, BAs lack sufficient information regarding proposed in-water work. It is essential that the discussion of in-water elements of a proposed project consider the following issues:

- Discuss specific methods of in-water construction.
- Discuss methods for determining culvert size.
- Discuss the duration of in-water work.

- Discuss the location of machinery, equipment, and staging areas in relation to the stream channel.
- Provide the amount of material to be placed along the channel banks and the amount of material to be placed within the wetted channel (e.g., fill, large woody debris, or boulders).
- Discuss whether piles will be driven by vibratory or impact methods.
- Describe stream bypass methods.
- Discuss the extent of riparian vegetation removal and ground disturbance proposed in the vicinity of the water resource.
- Discuss the extent of potential direct and indirect effects of proposed actions on habitat and various life stages of fish species present.
- Consider the types of piles proposed and associated potential contaminants: treated wood (e.g., creosote, chromated copper arsenate (CCA), or polycyclic aromatic hydrocarbon compounds [PAHs]), cast-in-place or concrete piles (e.g., pH alterations or lime), or metal (e.g., treated or PVC coatings).
- Consider the impacts of removing piles: in some cases, sawing concrete piles off at the water line rather than at or below the mud line reduces impacts by preventing alterations to the pH of the water body. Removal of treated wood piles may have short-term adverse impacts resulting from the resuspension of contaminants but may improve environmental baseline conditions in the long term.
- Consider whether cofferdams will increase sediment impacts or effectively contain sediments so that sediments can be pumped to infiltration sites. Consider using water sausages to decrease sediment impacts.
- Consider sediment impacts resulting from bank trampling and compaction.
- Consider the impacts resulting from first flush: will the first rains after construction generate sediment loads above the natural disturbance regime, thus constituting an adverse effect?
- Discuss the quantity of sedimentation and dispersion (i.e., will it amount to a teaspoon or a truckload in a small or large system).
- Consider the size of the mixing zone and the behavior of sediments suspended in the water column. How far will sediment impacts extend? Is this extent of impact compatible with Department of Ecology guidelines for mixing zones?

- Describe conservation and BMP measures that will be implemented to minimize construction-related impacts.

- Discuss the timing of in-water work in relation to the presence of different life stages of listed species within the project action area.

- Describe work occurring within the in-water work windows stipulated by the WDFW area habitat biologist or the hydraulic project approval.

- If the project occurs in a seasonal stream when the channel is dry, describe the cleanup measures and the effect of first-flush impacts.

14.2 Information Resources

Information pertaining to the methods or construction techniques employed for in-water work is available from a number of sources, including but not limited to the sources listed below:

- WDFW: Hydraulic Project Approval Code (RCW 75.20 and WAC 220-110). Available online at <http://slc.leg.wa.gov/default.htm>.

- WDFW: *Design of Road Culverts for Fish Passage*. Available online at <http://wdfw.wa.gov/hab/engineer/cm/>.

- WDFW: *Integrated Streambank Protection Guidelines*. Available online at <http://wdfw.wa.gov/hab/ahg/strmbank.htm>.

- WDFW: *Fishway Design Guidelines for Washington State*. Available online at <http://wdfw.wa.gov/hab/ahg/fishguid.pdf>.

- *Best Management Practices to Protect Water Quality from Non-Point Source Pollution* (Warrington March 2000).

A summary of the activities regulated under the hydraulic code and their WAC citations are provided in Table 14-1. Additional guidelines and white papers referenced in Table 14-1 can be found online at <http://wdfw.wa.gov/hab/ahg/ahgwhite.htm>.

The Washington hydraulic code stipulates that all activities that alter the bed or flow of state waters (i.e., all in-water work) require a hydraulic project approval (HPA) permit from WDFW. Through the hydraulic code, WDFW is liable under the Endangered Species Act for any *take* that occurs as a result of projects it approves. In an effort to minimize impacts on species and avoid *take*, clear conditions are stipulated in the permits WDFW issues to project proponents, including in-water work windows.

Table 14-1. Activities regulated by the hydraulic code (WAC 220-110).

General WAC Topic	Topic/Activities	WAC Reference	Guidance or Guideline Reference
Bank protection	Bulkheads (lakes), instream structures (weirs, spurs, vortex structures, groins, barbs), beach enhancement (lakes), vegetative additions, river channel confinement and construction impacts, levee construction and removal, diversion of floodplain/hyporheic flow (forcing, floodway conveyance, relocation), floodplain fill placement	220-110-050, 220-110-223	Integrated Streambank Protection Guidelines (WDFW)
On-water and over-water structures	Docks, piers, floats, rafts, ramps, boat hoists, launches, boathouses, houseboats and associated moorings, marinas, driving or removal of pilings, trash-booms, trash-racks, work-barges, dolphins	220-110-060, 220-110-224, 220-110-290, 220-110-300, 220-110-330	Aquatic Habitat Guidelines white papers (WDFW)
Water crossings	Beach access, bridges, fords	220-11-070	Design of Road Culverts for Fish Passage (WDFW)
Culverts	Culverts - new and retrofits		Design of Road Culverts for Fish Passage (WDFW)
Water diversions	Screening devices, damming (small scale), pump intakes	220-110-190	Fishway Design Guidelines, Irrigation and Fish pamphlet (WDFW)
Conduit crossings	Trench cuts, borings, aerial, surface placement	220-110-100, 220-110-310	
Dredging and gravel removal	Instream sediment sumps, gravel pits, floodplain pits, dredging, gravel removal	220-110-130, 220-110-140, 220-110-320	Aquatic Habitat Guidelines white papers (WDFW)
Felling and yarding of timber	Non-FPA activities in Type 4-5 waters	220-110-160	
Aquatic plant control	Hand pulling, cutting, raking, bottom barriers, weed rollers, mechanical harvesting and cutting, diver dredging, dragline and clamshell dredging, rotovation, chemical controls	220-110-331 through 220-110-338	Aquatic Plants and Fish pamphlet (WDFW)
Aquaculture	Net pens, shellfish racks, hatchery racks, egg tubes, fish traps (see topics document)	None	
Marine resource issues	Bulkheads, marine beach nourishment, marine shoreline and near-shore activities, estuary restoration, vegetation (eelgrass, kelp beds, wetland, estuary)	220-110-280, 220-110-285	Aquatic Habitat Guidelines white papers (WDFW)
Channel design features	Spawning pads; habitat enhancement; off-channel rearing and other ponds; large woody debris (LWD)- removal, repositioning, addition; channel changes and realignment; off-channel channels (new floodplain and high flow bypass); gradient control structures	220-110-080, 220-110-150, 220-110-180	Macro-Habitat Restoration Techniques, Aquatic Habitat Guidelines white papers, Siting and Design of Off-Channel Rearing Habitat (WDFW)
Mineral prospecting	Panning and high banking, sluicing and dredging	220-110-200 through 220-110-209	Gold and Fish pamphlet (WDFW)
Stormwater	Quantity, quality, outfalls and other instream structures	220-110-170	Ecology stormwater manual (1992)

WDFW area habitat biologists currently reference two state pamphlets for general guidance in determining in-water work windows: *Gold and Fish* and *Aquatic Plants and Fish* (see online citation below). The general timing restrictions stipulated in these documents are then modified by area biologists, based on their knowledge or observations of site-specific conditions, in order to provide sufficient habitat protection and minimize potential impacts on species.

The *Gold and Fish* pamphlet is available online at <http://wdfw.wa.gov/licensing/mining/>.

The *Aquatic Plants and Fish* pamphlet is available online at <http://wdfw.wa.gov/publications/pub.php?id=00713>.

By including HPA conditions in the BA impact minimization measures, project impacts can be reduced. However, the timing of the in-water work window as defined by WDFW in an HPA can differ from the window defined by NOAA Fisheries and USFWS, because the guidance used by WDFW habitat biologists in determining in-water work windows has not been formally approved by NOAA Fisheries and USFWS. The guidance used by state biologists emphasizes the sensitive periods for all species that WDFW addresses, not just listed fish species, and is generally provided at the county level, although more specific windows have been defined for some basins and subbasins.

In contrast, the work windows defined by biologists from the Services focus upon sensitive periods and the presence of listed fish species in watercourses. It is important that the BA report the in-water work window that has been approved by all three agencies (USFWS, NOAA Fisheries, and WDFW). This is the window that must be included in the special provisions. Any changes to the in-water work window proposed by the project must be approved by all three agencies.

14.3 Guidance for Effect Determinations Pertaining to In-Water Work

WSDOT has developed guidance for effect determinations related to in-water work activities. The following information is intended as guidance only and has not been uniformly accepted by the Services as providing adequate coverage for listed species or critical habitats. In addition, site-specific conditions largely determine the types and extent of impacts that will result from in-water work activities. As a result, there likely will be significant variation in the effect determinations generated for different projects.

Work conducted within the wetted channel of a riparian system or in marine waters can be expected to result in impacts on surrounding habitats and species in virtually every case. Consequently, the most common effect determinations for in-water work are *not likely to adversely affect* and *likely to adversely affect*. The effect determinations recommended below for in-water work are project-specific and may not apply to every project.

Determination of No Effect *for In-Water Work Projects*

Projects that include in-water work will have *no effect* on listed fish species if the following condition is met:

- Work occurs outside a WRIA with a listed fish evolutionarily significant unit (ESU) or distinct population segment (DPS), or in WRIAs containing no listed fish species.

Determination of May Affect but Is Not Likely to Adversely Affect *for In-Water Work Projects*

Projects that include in-water work *may affect but are not likely to adversely affect* listed fish species if the following conditions are met:

- For work below the OHWM to replace or extend culverts: no ESA-listed species are present in the system during the approved work window, and no spawning habitat will be disturbed.
- All work is conducted within the WDFW stipulated in-water work window (in accordance with the *Gold and Fish* rule or a hydraulic project approval [HPA] permit).
- All work occurs outside rearing and spawning areas.
- The project does not degrade the environmental baseline.

Determination of May Affect and Is Likely to Adversely Affect *for In-Water Work Projects*

Projects that include in-water work *may affect and are likely to adversely affect* listed fish species under the following conditions:

- The project requires work in water where residual Chinook salmon or other rearing listed salmonids are present.
- The project requires moving or handling listed fish species.
- The project requires in-water work and has the potential for a direct *take* of listed species, including electrofishing or handling of listed fish.
- The project involves disturbance or filling of wetlands that are hydrologically connected (i.e., have a seasonal surface flow connection) to salmonid-bearing streams and provide rearing or refugia habitat for listed salmonids, whose habitat is in short supply in the watershed.

- The project requires blasting to remove slide material, and there is a high potential for materials to enter listed fish-bearing waters when listed fish are likely to be present.

Scheduling work within the WDFW-approved work window does not necessarily ensure that the proposed timing of the project will be accepted by the Services. The Service biologists and reviewers should be consulted prior to completion of a BA to ensure that optimal timing for in-water work is used.

In addition, there is some debate within the Services regarding how to adequately demonstrate any degradation of the environmental baseline in relation to a project action area. The project biologist should identify the environmental characteristics of the project action area and consider all possible effects upon those current conditions that may result from project activities. Whenever possible, effects of a proposed action should be qualitatively or quantitatively described to provide reviewers with a clear sense of the potential for project-related impacts to affect baseline conditions and the extent of those impacts.

If listed fish species are present in the project action area during construction, or if rearing or spawning habitat is present and will be damaged or affected by project activities, it is likely that in-water work will warrant a *likely to adversely affect* determination. In listed bull trout spawning subwatersheds, the presence of bull trout can be assumed year-round due to the variety of life history forms that exist.

The BA should include a minimization measure requiring that only personnel with fish experience may move the fish from an in-water work area.

14.4 Fish Removal or Exclusion

Because in-water work often necessitates the exclusion or removal of fish from the project construction area, Federal resource agencies expressed an interest in the Washington State Department of Transportation (WSDOT) developing a work area isolation/fish removal protocol for agency activities where fish removal may be necessary. The WSDOT Fish Removal Protocols and Standards was developed in an attempt to standardize WSDOT's activities when they are required to remove fish from work areas.

Projects with fish moving or exclusion activities should include the most recent protocol as an appendix to a BA. In some situations, the protocol may not apply or may be modified in emergency situations or in certain areas that have unique site-specific characteristics.

The Fish Exclusion Standards and Protocol is available online at <http://www.wsdot.wa.gov/Environment/Biology/BA/BAtemplates.htm>.

15.0 Performance-Based, Batched, and Programmatic Biological Assessments

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15.0 Performance-Based, Batched, and Programmatic Biological Assessments

Chapter Summary

- Performance-based biological assessments (BAs) and biological evaluations (BEs) are often written early in the design phase of a project. Because detailed information on the project description and design is lacking at that early stage, these reports are general in nature and are intended to provide safeguards for habitat and species by defining actions that will not be included in the project or impacts that will be avoided.
- Batched BAs and programmatic BAs or BEs provide collective coverage for groups of projects.
- Batched BAs can be grouped by project type or by geographic location.
- Programmatic BAs and programmatic BEs typically are written to cover several project types with NE, NLTAA, and LTAA determinations focusing on either: 1) a finite period of time (defined in the programmatic BA), 2) a defined geographic area, or 3) a particular species.
- Programmatic BAs and BEs establish conditions allowing specific activities that occur within general programs to proceed without individual concurrence from the Services for each project, provided that the project meets the requirements of the programmatic BA or BE.
- The U.S. Army Corps of Engineers has four programmatic BEs/BAs available for public use in Washington State.
    - The first Corps programmatic BE covers many of the common activities permitted under their Nationwide Permit program. Details on Phase 1 activities and the species that are covered are provided in Section 4.2.1.
    - The second Corps of Engineers programmatic BA is titled: Programmatic Biological Assessment for Fish Passage and Habitat Restoration in Washington State. It addresses primarily beneficial restoration projects that may affect species administered by both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Specific activities are given in Section 4.2.2.
    - The third and fourth Corps Programmatic consultations cover activities specifically located within Lake Washington and Lake Sammamish.

This chapter provides a general overview of performance-based BAs, batched BAs, and programmatic BAs and BEs, and identifies information sources for learning more about them. This chapter also discusses the Corps of Engineers programmatic BE/BAs.

15.1 General Considerations

Any major construction project with a federal nexus (defined as receiving federal funding, requiring federal permits, or taking place on federal lands) is required under the Endangered Species Act to submit a BA to evaluate the impact of the project on listed species. This in turn requires consultation with the Services.

The process of producing a BA and receiving concurrence from the Services can take from one month to one year, depending upon the complexity of the proposed project. The Services and many action agencies have been working to streamline this process. These entities increasingly have been developing BAs early in the design process, in some cases, performance-based BAs.

The Services and action agencies also have been developing BAs that provide coverage for multiple projects within a single encompassing report. These documents, called batched BAs and programmatic biological assessments or biological evaluations, provide collective coverage for groups of projects of several types:

- Specific projects of a similar type (batched BA)
- Specific projects that take place in a similar region (batched BA)
- General programs of activities rather than individual projects (programmatic BA or BE).

15.1.1 Performance-Based Biological Assessments

Occasionally, BAs must be developed early in the design phase of a project in order to support the National Environmental Policy Act (NEPA) process. NEPA EIS documents cannot be signed and adopted until the ESA Section 7 consultation process has been completed. Performance-based BAs are usually written for large, complex projects requiring years to complete project designs and secure all necessary permits.

A performance-based BA is often written before there is a detailed description of the proposed action or even before an alternative is chosen. In order to develop effect determinations that can be supported, these BAs must establish safeguards for habitat and species that will be implemented by the project. These safeguards often outline activities that will *not* be included in a project (e.g., the project will not entail in-water work, will not disturb riparian vegetation, will not fill wetlands, or will avoid placing bridge elements below the OHWM). Often these BAs place limitations on the scope of the project and project impacts (e.g., the bridge will span the entire floodplain; the project will be completed within one construction season; or no more than one acre of vegetation will be removed). Lacking a clear project description, a performance-based BA defines the project by specifying activities and elements that are not included or allowed in the project.

Because these BAs are written prior to completing project designs, often consultation must be reinitiated after the scope of the project has been more clearly defined. Reinitiation in this case allows for a more detailed and thorough analysis of effects based upon current or final project designs.

15.1.2 Batched Biological Assessments

Projects can be grouped by project type (e.g., pavers or bridge scour repair) or by geographic location (e.g., projects within a single watershed). General impacts are identified, discussed, and evaluated in the batched BA, and minimization measures are developed to minimize these common impacts. Site-specific impacts are discussed as necessary in relation to the projects. WSDOT has successfully used batched BAs to address paving projects.

15.1.3 Programmatic Biological Assessments and Biological Evaluations

Programmatic BAs and BEs typically are written to cover several project types with NE, NLTAA, and LTAA calls, either within a defined geographic area, over a limited period of time, or for a particular species (as defined in the programmatic BA). The programmatic BA may be approved by one or both of the Services.

Programmatic BAs group together projects within specific programs (e.g., several activities that fall under the safety improvement program [such as guardrail work, traffic signal installation or replacement, slope flattening, or tree removal from the clear zone] or the environmental retrofit and restoration program [such as culvert replacement, stormwater treatment facility installation, correction of fish barriers, or installation of large woody debris]). Specific effect determination criteria are identified for each species addressed in the programmatic BA. Projects that cannot meet the criteria defined in the programmatic BA may require an individual BA for review and concurrence by the Services.

A project biologist reviews each individual project to determine whether it meets the requirements outlined in the programmatic BA. If a project meets those requirements, the project evaluation or assessment is documented through the use of a programmatic BA form or an abbreviated BA report, which is sent to the Services. In most cases, projects complete their Section 7 requirements through the programmatic BA, so that individual concurrence from the Services is not required.

The process used for consultation and to document and track projects receiving coverage under a programmatic BA may differ slightly among programmatic BAs. For each programmatic BA, a form or an abbreviated BA template is provided to facilitate ongoing documentation of the projects covered under that programmatic BA. This template is filled out by the action agency in coordination with the Services.

The Army Corps of Engineers (Corps) has four programmatic consultations in Washington State that address many minor construction activities that it implements directly or for which it issues permits, as well as fish passage and restoration activities. Each programmatic consultation is addressed in Section 15.2.

WSDOT has developed programmatic BAs for internal use by WSDOT biologists. WSDOT currently uses two programmatic BAs. One programmatic BA addresses projects and species in eastern Washington that are under USFWS jurisdiction (*Programmatic Biological Assessment for Eastern Washington Regions*); the second programmatic BA covers projects and USFWS species in western Washington. These programmatic BAs apply only to a selection of WSDOT *no effect*, *not likely to adversely affect*, and *likely to adversely affect* projects.

WSDOT programmatic BAs are intended for use only by WSDOT biologists and are not available for use outside WSDOT.

15.1.4 Information Sources

The programmatic consultations the Corps has completed, as well as information on the required timing windows specified in these programmatic documents, are available online at <http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=Programmatics>.

Guidance provided by USFWS for transportation agencies developing programmatic strategies is available on the USFWS website or on the compact disc accompanying this manual. Also provided on this website is an outline of the general process for developing programmatic BAs (<http://www.fws.gov/endangered/what-we-do/consultation-stories.html>).

15.2 U.S. Army Corps of Engineers Programmatic Biological Evaluations/Assessments

15.2.1 Programmatic Biological Evaluation for the State of Washington for Salmonid Species Listed or Proposed by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service Under the Endangered Species Act (Phase 1 Programmatic) and Revisions to Regional General Permits (RGP) 1 and 6 (Watercraft Lifts in Fresh and Marine/Estuarine Waters and Overwater Structures in Inland Marine Waters)

The Corps of Engineers produced this BE for portions of its nationwide and regional permit programs. The programmatic BE received concurrence from NOAA Fisheries on January 16, 2008, and from USFWS on September 9, 2009.

The applicant must submit a Specific Project Information Form (SPIF) to the Corps, with subsequent approval by the Corps, and in some cases the U.S. Fish and Wildlife Service. Sixty-eight potential Conservation Measures may be used.

Activities are allowed within the State of Washington with a few exceptions:

> Effects to USFWS administered species are not covered in Lake Washington and Lake Sammamish (activities there are covered in a separate agreement); and

Effects to NMFS administered species are not covered for some activities in the Columbia River mainstem and Baker Bay.

This programmatic BE can be applied to actions covered under certain nationwide permits or regional general permits that the Corps believes merit a determination of NLTAA for fish and other species or designated critical habitat. Specific projects include the following:

- Aids to navigation
- Mooring buoys
- Piling repair and replacement (replacement of up to 20 existing pilings per structure using vibratory installation to the extent possible)
- Scientific measurement devices
- Oil spill containment
- Fish and wildlife harvesting
- Tideland markers
- Nearshore fill for State Hydraulic Project approval mitigation requirements
- Temporary recreational structures (not approved for listed salmon and steelhead)
- Minor bank stabilization, freshwater
- Minor bank stabilization, marine/estuarine
- Watercraft lifts and boat canopies, Regional General Permit 1
- Overwater structures in inland marine waters, Regional General Permit 6

The descriptions and conditions for the activities covered under the programmatic consultation may have conditions for specific species, activities, and geographical areas. Additionally, all activities must comply with the general implementation conditions and timing windows of the programmatic consultations.

15.2.2 Programmatic Biological Assessment for Fish Passage and Habitat Restoration Actions in Washington State

This programmatic BA (June 6, 2008; revised July 29, 2008) primarily addresses fish habitat restoration. NOAA Fisheries and the USFWS issued a joint biological opinion on July 8, 2008. The programmatic covers the short-term adverse effects of restoration projects such as temporary water quality impacts or fish handling. However, the general long-term aspect of the project must be beneficial to aquatic life. The activities covered under this programmatic consultation include:

- Fish passage
- Installation of instream structures
- Levee removal and modification
- Side channel/off channel habitat restoration and reconnection
- Salmonid spawning gravel restoration
- Forage fish spawning gravel restoration
- Hardened fords for livestock crossings of stream and fencing
- Irrigation screen installation and replacement
- Debris and structure removal

The Corps, USFWS, and NMFS are currently working on a revised PBA, which will cover newly listed species and designated critical habitats. The PBA will also include new action categories. The revised PBA is anticipated in 2011. Similar to the limitations described for the Phase I programmatic BE, restoration projects must meet defined Conservation Measures stipulated in the document for each Action Category.

15.2.3 Programmatic Biological Assessment for Selected Activities in the Lake Washington and Lake Sammamish Basins.

A programmatic letter of concurrence was issued by the USFWS to the Corps on June 25, 2009. This programmatic covers certain actions to bull trout and bull trout critical habitat in the Lake Washington and Lake Sammamish basins. Only activities that result in may effect, not likely to adversely affect determinations are covered. Activities include:

- Overwater structures
- Boat lift, jet-ski lift, installation or relocation

- Fill placement
- Shoreline stabilization
- Shoreline/riparian enhancement; and irrigation withdrawals

The applicant must submit a Specific Project Information Form (SPIF) to the Corps. Mandatory conservation measures are needed for each activity.

15.2.4 Programmatic Biological Evaluation for Shoreline Protection Alternatives in Lake Washington

This programmatic is used for replacing existing rip rap and concrete bulkhead projects in Lake Washington. It covers both USFWS and NOAA Fisheries administered species.

16.0 Essential Fish Habitat

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16.0 Essential Fish Habitat

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- Three federal fishery management plans and their associated *essential fish habitat* (EFH) are applicable to projects within Washington state: the Pacific coast groundfish fishery, the coastal pelagic species fishery, and the Pacific coast salmon fishery.
- The groundfish fishery includes 83 species, 61 of which occur in Washington State, 35 of which occur in Puget Sound.
- The coastal pelagic fishery includes four fin fishes (Pacific sardine, Pacific [chub] mackerel, northern anchovy, and jack mackerel) and the invertebrate market squid.
- The Pacific salmon fishery includes Chinook, coho, and Puget Sound pink salmon.
- If the federal action agency determines that an action or proposed action may have an adverse effect on essential fish habitat, consultation is required.
- If the federal action agency determines that an action or proposed action will not have an adverse effect on essential fish habitat, consultation is not required.
- In an essential fish habitat assessment, the federal action agency provides to NOAA Fisheries a description of the proposed action, an analysis of effects, minimization measures or proposed mitigation that will be incorporated into the project to minimize potential adverse effects on essential fish habitat, and an effect determination.
- If the essential fish habitat assessment is packaged with the BA, it should be a self-contained document included after the ESA biological assessment, but before the reference section.
- Rather than repeating information provided in the BA, the essential fish habitat assessment can cross-reference relevant sections in the BA that analyze potential project impacts on species or critical habitat.
- Discussion of project effects on essential fish habitat should be general and should be based on the habitat rather than each species.

- Effect determinations should be made for each group of species rather than for each species.

This chapter provides general information on essential fish habitat and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), including information pertaining to each of the three federally managed fisheries and their associated essential fish habitat located in Washington state, an overview of the consultation process, guidance for analyzing effects on essential fish habitat, guidance for effect determinations, recommendations for content and language (provided by WSDOT), and a template for essential fish habitat assessments.

16.1 Statutory Protection of Essential Fish Habitat

The Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect essential fish habitat. In addition, the law requires fishery management councils to include descriptions of essential fish habitat and potential threats to essential fish habitat in all federal fishery management plans.

Essential fish habitat is defined in the Magnuson-Stevens Act as *those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity*. The law provides the following additional definitions for clarification:

- “Waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate.
- “Substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- “Necessary” means the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem.
- “Spawning, breeding, feeding, or growth to maturity” covers the full life cycle of a species.

Three federal fishery management plans and their associated essential fish habitat are applicable to projects and activities within Washington state: the Pacific coast ground fish fishery, the coastal pelagic species fishery, and the Pacific coast salmon fishery. The ground fish fishery includes 83 species (approximately 60 of which occur in Washington); the coastal pelagic fishery includes four fin fishes (Pacific sardine, Pacific [chub] mackerel, northern anchovy, and jack mackerel) and the invertebrate market squid; and the salmon fishery includes Chinook, coho, and Puget Sound pink salmon.

The University of California at San Diego sponsors an excellent online source of information for essential fish habitat issues: <http://swr.ucsd.edu/efh.htm>. The NOAA Fisheries website is also useful: <http://www.nwr.noaa.gov/Salmon-Habitat/Salmon-EFH/>.

16.1.1 Pacific Groundfishes

Research on the life histories and habitats of these species varies in completeness. While some species are well studied, there is relatively little information on certain other species. Information about the habitats and life histories of the species managed by the Pacific coast groundfish fishery management plan is evolving, with varying degrees of improvement in information for each species.

In November 2005, the Pacific Fishery Management Council released Appendix B3 to the Pacific Coast Groundfish Fishery Management Plan. This appendix provides detailed descriptions of EFH for groundfish species based on habitat use, species and life stage distribution, and prey associations. The fundamental variables for determining if a particular area is EFH for a particular species are latitude, substrate and depth, which overlap with areas of observed prey species. The Pacific Habitat Use Relational Database (HUD) has been developed to provide a flexible, logical structure within which information on the uses of habitats by species and life stages in the west coast groundfish species complex can be stored, summarized and analyzed as necessary. Appendix B3 includes a series of tables providing output from the HUD model. The HUD tables provide a detailed text description of groundfish EFH pursuant to guidelines at 50 CFR 600.815(a).

The tables consist of the following:

- Shaded header row lists each groundfish species' common name, genus and species
- Lifestage; i.e. adult, juvenile, etc.
- Minimum/maximum depth (meters) are listed for each lifestage
- Minimum/maximum latitude (decimal degrees north) are listed for each lifestage
- Preferred habitat combinations listed with associated activities and observed prey

Most species/lifestages are observed within multiple habitat combinations and therefore many species/lifestages will have multiple habitat combinations listed below them. The habitat preferences are broken down by four life stages: eggs, larvae, juveniles and adults. The HUD contains absolute depth as well as latitude values for the four life stages of most species in the FMP. All depths listed are in meters. All latitudes are in decimal degrees north.

EFH is limited to US waters. In the instances where the text description includes a latitude range that extends beyond US waters, EFH stops at the boundary.

Preferred habitat types are classified according to their physical features. The habitat classifications are currently independent and are not structured as sub sets within one another. For the west coast, the following types have been delineated:

Table 16-1. Habitat classifications for groundfish.

Megahabitat	Induration	Meso/macro habitat	Modifier	
Abyssal Plain	Basin	Artificial Structure	Algal Beds/Macro	Mud/Rock
Coastal Intertidal	Benthos	Biogenic	Artificial Reef	Oil/Gas Platform Piers
Estuarine	Intertidal Benthos	Epipelagic Zone	Basketstars	Rooted Vascular
Inland Sea	Seamount	Hard Bottom	Bedrock	Sand
Island Shelf	Submarine Canyon	Mesopelagic Zone	Boulder	Sand/Boulders
Nearshore	Unknown	Mixed Bottom	Brittlestars	Sand/Cobble
Shelf	Water Column	Tide Pool Unconsolidated Unknown	Clay	Sand/Gravel
Slope/Rise		Vegetated Bottom	Cobble	Sand/Rock
Slope/Rise/Plain			Current System	Sea anemones
			Demosponges	Sea Lilies
			Drift Algae	Sea Urchins
			Fronts	Sea Whips
			Gooseneck barnacles	Seawater surface
			Gravel	Silt
			Gravel/Cobble	Silt/Sand
			Gravel/Rock	Soft Bottom/Boulder
			Macrophyte Canopy	Soft Bottom/Rock
			Mixed mud/sand	Sponges
			Mud	Tube Worms
			Mud/Boulders	Unknown
			Mud/Cobble	Vase Sponges
			Mud/Gravel	

Each combination of these four levels defines a unique habitat type. The observed activity and prey are reported for each of these unique combinations of preferred habitat type.

EFH is defined by the Magnuson-Stevens Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. 1802(10)). Therefore the terms spawning, feeding and growth to maturity are used in the tables to describe observed activities. In some habitats, all of these activities are observed. Other habitats have unknown activities associated with them.

Prey observed within the habitat type are listed as specifically as possible in the tables. Attempts are made to list as a taxonomic group, ranging from Family name, to genus and species. Occasionally only a descriptive name is available.

There are instances where no data is available from the literature. Blanks in the tables represent these data gaps.

The EFH description tables are available on NMFS website: <http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/NEPA-Documents/EFH-Final-EIS.cfm>.

16.1.2 Coastal Pelagic Species

The coastal pelagic species fin fishes generally occur above the thermocline in the upper mixed layer and are therefore considered pelagic (occurring in the water column near the surface and not associated with substrate). For the purposes of essential fish habitat, the four fin fishes (Pacific sardine, Pacific [chub] mackerel, northern anchovy, and jack mackerel) are treated as a single species complex because of the similarities in their life history and habitat requirements. Market squid are also treated in this same complex because they are also fished above spawning aggregations.

16.1.3 Pacific Salmon

U.S. Geological Survey (USGS) hydrologic units are used as the descriptor of essential fish habitat. The EFH for the Pacific coast salmon fishery is defined as those waters and substrate necessary for salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. To achieve that level of production, EFH must include all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. This does not include habitats above the impassible barriers identified by the Pacific Fishery Management Council Fishery Management Plan (PFMC 1999).

In the estuarine and marine areas, salmon EFH extends from the near-shore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception.

Foreign waters off Canada, while still salmon habitat, are not included in salmon EFH because they are outside United States jurisdiction. The Pacific coast salmon fishery also includes the marine areas off Alaska designated as salmon EFH by the North Pacific Fishery Management Council. This identification of EFH is based on the habitat used by coho, Chinook, and pink salmon.

16.2 Essential Fish Habitat Consultation

Essential fish habitat consultations address species in the federally managed Pacific groundfish fishery, the coastal pelagic species fishery, and the Pacific salmon fishery. If the federal action agency determines that an action or proposed action may have an adverse effect on EFH, consultation is required. If the federal action agency determines that an action or proposed action will not have an adverse effect on EFH, consultation is not required.

Usually, but not always, when impacts of a proposed action affect species under NOAA Fisheries jurisdiction, EFH species or EFH itself also will sustain impacts from the proposed action. Consequently, the analysis of effects on EFH can often cross-reference the effects analysis provided within the BA for NOAA Fisheries species and critical habitat protected under the Endangered Species Act.

In some situations a separate EFH impact analysis may be required (e.g., cases in which a project does not affect the evolutionarily significant unit of a listed species, but is located where Chinook, pink, or coho salmon or ground fishes occur). In another example, a separate analysis is appropriate when a BA only addresses impacts on bull trout and bull trout habitat, requiring additional analysis of potential impacts on coho, Chinook, and pink salmon habitats, as well as habitat for ground fish or coastal pelagic species, in order to adequately address essential fish habitat.

There are four components of an essential fish habitat consultation:

- **Notification**—the federal action agency notifies NOAA Fisheries of an activity that may adversely affect EFH.
- **Essential fish habitat assessment**—the federal action agency provides NOAA Fisheries with a description of the proposed action, analysis of effects, and effect determination.
- **Conservation recommendations**—NOAA Fisheries involves the federal action agency in development of advisory EFH conservation recommendations and provides them to the federal agency.
- **Federal action agency response**—the federal action agency provides a written response to NOAA Fisheries within 30 days after receiving NOAA Fisheries conservation recommendations.

If the determination is that the proposed action may have an adverse effect on essential fish habitat, NOAA Fisheries must provide EFH conservation recommendations to the federal action agency that submitted the environmental documentation. The federal action agency must then provide a detailed written response within 30 days of receiving the recommendations (or at least 10 days prior to final approval of the action, if a decision by the federal action agency is required in less than 30 days).

The written response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. If the response is inconsistent with the recommendations made by NOAA Fisheries, adequate justification for not following the recommendations by NOAA Fisheries must be provided.

16.3 Analysis of Effects: Magnuson-Stevens Act and Essential Fish Habitat

To streamline the essential fish habitat consultation process, consultation can occur under NEPA, ESA, or another federal process agreed upon by NOAA Fisheries and the federal action agency. FHWA-funded projects may be streamlined by combining the EFH analysis with ESA Section 7 consultation. The analysis of project impacts on EFH should be prepared as a separate assessment document, to be included after the ESA BA.

Since the BA contains a detailed analysis of project impacts on critical habitat and the environmental baseline, it may already address most requirements of the EFH impact analysis. The adverse effects analysis discussed in the portion of the BA or BE addressing ESA requirements can be referenced in the EFH section of the document to avoid repetition.

In addition, it is not necessary to discuss the adverse effects on EFH on a species-by-species basis, as this would also be repetitive and would provide the reviewer with no additional information. Instead, the project's effects on EFH should be discussed more generally. If the minimization measures discussed in the ESA portion of the document will also minimize the potential adverse effects on EFH the project biologist may refer to that earlier description.

In general, the EFH assessment is not expected to exceed one page in length if other sections of the BA are referenced. However, if independent EFH analyses are required to address habitats not addressed in the BA, the report may be somewhat longer.

The objective of an EFH assessment is to determine whether the proposed action may adversely affect or will not adversely affect designated EFH for relevant federally managed commercial fishery species within the project action area. Therefore, the appropriate determination is either *may adversely affect* or *will not adversely effect*. There is no *may affect, not likely to adversely affect* category for EFH as there is under ESA.

If the designated EFH is for the Pacific coast salmon fishery, one effect determination must be made for Pacific salmon EFH. In instances where effects on an individual species are unique, an effect determination may be made for the EFH of a specific species (coho, Chinook, or Puget Sound pink). If the EFH in the project area is associated with a ground fish or coastal pelagic species, an effect determination for EFH may be made for each of these species groups.

The analysis must also describe minimization measures proposed to avoid, minimize, or otherwise offset potential adverse effects on designated EFH resulting from a proposed action. The actual EFH discussed depends upon the project location and the species potentially present. Unless it is clear that the effects on a particular species are unique, it is not advisable to discuss the adverse effects on a species-by-species basis. Discussion of project effects on EFH should be general and based on the habitat rather than each species.

The following information should be provided in an essential fish habitat assessment:

- Action agency title
- Project name
- Background information on the Magnuson-Stevens Act and definition of essential fish habitat
- Description of the proposed activity
- A definition of the essential fish habitat designation for the fisheries potentially affected by the project
- An identification of the fisheries species likely to occur in the project area and a brief description of their use of the project action area (significant prey species [e.g., Pacific sand lance] should also be considered)
- Description of individual and cumulative adverse effects (and beneficial effects, if any) of the proposed project on relevant EFH, the managed species (including affected life history stages), and associated species such as major prey species
- Description of EFH minimization measures or proposed mitigation incorporated into the project to minimize potential adverse effects on EFH (additional conservation recommendations may be developed by NOAA Fisheries upon review of the assessment)
- Conclusion and a summary of potential effects on EFH taking into account the minimization measures stipulated in the previous section
- References to information sources that are specific to the EFH analysis, including information regarding the EFH-specific species occurring in the project action area and the descriptions and definitions of EFH used by the project biologist in the assessment (some of the most frequently used references are provided in the EFH assessment template at the end of this chapter)

The general essential fish habitat consultation and assessment process is similar to the consultation and assessment performed for ESA-regulated species and habitats, as illustrated at the end of this chapter in the detailed EFH assessment template. Additional information on west coast ground fishes is provided in the *EFH Excerpt from Amendment 11—Groundfish Fishery Management Plan*, which is provided on the compact disc accompanying this manual.

Additional information on EFH consultation can be found online at <http://www.nwr.noaa.gov/Salmon-Habitat/Salmon-EFH/Index.cfm>.

16.4 Guidance for Essential Fish Habitat Effect Determinations

Detailed guidance on essential fish habitat effects analysis is provided on the NOAA Fisheries website: <http://www.nwr.noaa.gov/Salmon-Habitat/Salmon-EFH/Index.cfm>.

A separate effect determination must be made for the essential fish habitat of each fishery (species group) that occurs in the project area. Hence a single report may contain an effect determination for several different kinds of EFH; one for Pacific coast salmonids, one for ground fishes, and one for coastal pelagic species.

16.5 Essential Fish Habitat Analysis Language

Essential fish habitat applies to several species that are not listed under the Endangered Species Act. Therefore, unlisted species may need to be addressed in the analysis of EFH impacts.

The example below contains recommended content and language for an analysis of EFH concerning species under NOAA Fisheries jurisdiction.

Recommended content for essential fish habitat analysis (to be provided in as a stand-alone document after the ESA BA):
Describe the law protecting essential fish habitat, how EFH is defined, the species considered under EFH, the occurrence of EFH within the project action area, and any impacts likely to affect EFH from the project activities. Habitat of prey species for the species considered under EFH should also be addressed. The impact analysis should not be lengthy if ESA-listed fishes are addressed in the BA, because most potential impacts on EFH should be addressed in this prior analysis. A determination of may adversely effect should be made if the action results in the reduction of quantity or quality of EFH. Otherwise, a determination of will not adversely effect or no adverse effect is appropriate.

Sample language for essential fish habitat analysis (to be provided in as a stand-alone document after the ESA BA):
The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) includes a mandate that NOAA Fisheries must identify essential fish habitat (EFH) for federally managed marine fishes, and federal agencies must consult with NOAA Fisheries on all activities or proposed activities authorized, funded, or undertaken by the agency that may adversely affect EFH. The Pacific Fisheries Management Council (PFMC) has designated EFH for the Pacific salmon fishery, federally managed ground fishes, and coastal pelagic fisheries (NOAA Fisheries 1999; PFMC 1999).

The EFH designation for the Pacific salmon fishery includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except above the impassible barriers identified by PFMC (1999). In estuarine and marine areas, proposed designated EFH for salmon extends from near-shore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California north of Point Conception (PFMC 1999).

The Pacific salmon management unit includes Chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), and pink salmon (*Oncorhynchus gorbuscha*). All three of these species use Hood Canal for adult migration, juvenile out-migration, and rearing where suitable habitat is present. Coho and Chinook are known to stage in Hood Canal as subadults.

The EFH designation for ground fishes and coastal pelagics is defined as those waters and substrate necessary to ensure the production needed to support a long-term sustainable fishery. The marine extent of ground fish and coastal pelagic EFH includes those waters from the near-shore and tidal submerged environment within Washington, Oregon, and California state territorial waters out to the exclusive economic zone (370.4 km [231.5 miles]) offshore between Canada and the Mexican border.

The west coast ground fish management unit includes 83 species that typically live on or near the bottom of the ocean. Species groups include skates and sharks, rockfishes (55 species), flatfishes (12 species) and ground fishes. Ground fishes such as lingcod (*Ophiodon elongates*), Cabezon (*Scorpaenichthys marmoratus*), and brown rockfish (*Sebastes auriculatus*) potentially occur in Hood Canal (NOAA Fisheries 1998). Coastal pelagics are schooling fishes, not associated with the ocean bottom, that migrate in coastal waters. West coast pelagics include the pacific sardine (*Sardinops sagax*), Pacific chub *(Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*). These fishes are primarily associated with the open ocean and coastal areas (PFMC 1998) and are not likely to occur in the project area.

The Pacific sand lance (*Ammodytes hexapterus*) is an important forage fish for juvenile Chinook salmon. Loss of prey is considered an adverse effect on EFH. The Pacific sand lance is known to breed in Hood Canal.

Essential fish habitat for ground fishes and Pacific salmon is present in the project action area. The project will result in a minor, temporary effect on water quality. No permanent adverse effects on EFH for ground fishes, coastal pelagics, Pacific salmonids, or their prey species will result from the geotechnical test drilling. Therefore, the project will not adversely affect EFH for ground fishes, coastal pelagics, or Pacific salmonids.

16.6 Essential Fish Habitat Assessment Template

This template is intended to aid in the preparation of essential fish habitat assessments, which must contain the following information (see 50 CFR 600.920(g)):

- A description of the proposed project

- An analysis of the effects (including cumulative effects) of the proposed action on essential fish habitat and the managed species and associated species, such as major prey species, including affected life history stages

- The federal agency's views regarding the effects of the action on essential fish habitat

- Proposed mitigation, if applicable.

The essential fish habitat assessment template is available online at <http://www.nwr.noaa.gov/Salmon-Habitat/Salmon-EFH/Index.cfm>.

This template is intended as a guide in preparing an essential fish habitat assessment and can be modified as the writer sees fit. The text in italics is explanatory and should be removed from the final product.

If the essential fish habitat assessment accompanies a biological assessment or biological evaluation that will be provided to NOAA Fisheries, the information already supplied in the BA or BE can be referenced and need not be repeated in the EFH assessment. Headings that do not provide the information required by the EFH regulations, such as Action Agency and Project Name (which are already identified in the BA) need not be repeated in the EFH assessment appendix.

Essential Fish Habitat Assessment for
[project name and location]

Action Agency: *[name of project proponent]*

Project Name: *[project name and location]*

Essential Fish Habitat Background

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect essential fish habitat (EFH).

The objective of this EFH assessment is to determine whether or not the proposed action(s) "may adversely affect" designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

Description of the Proposed Action

Describe the project, or reference the description presented in previous sections of the BA. If a previous section is referenced, briefly describe the project in one or *two lines. The species and life-history stages affected should be noted here. They can be listed in table form (see Table 16-2). This table was constructed using the references at the end of the template.*

Table 16-2. Fish species and life-stages with designated essential fish habitat in the action area.

Ground Fish Species	Eggs	Larvae	Young Juvenile	Juvenile	Adult	Spawning
Spiny dogfish			X	X	X	
Ratfish				X	X	
Lingcod		X		X	X	X
Cabezon		X				
Kelp greenling		X				
Pacific cod		X	X	X	X	X
Pacific whiting (hake)			X	X	X	
Sablefish		X	X	X	X	X
Darkblotched rockfish				X	X	
Greenstriped rockfish				X	X	
Thornyhead		X				
Pacific Ocean perch				X	X	
Widow rockfish			X	X		
Miscellaneous rockfish				X	X	
Arrowtooth flounder				X	X	
Butter sole	X	X				
Curlfin sole	X					
Dover sole	X			X	X	
English sole	X	X	X	X	X	X
Flathead sole		X		X	X	X
Pacific sanddab				X	X	
Petrale sole			X	X	X	
Rex sole	X	X		X	X	
Sand sole	X	X				
Starry flounder	X	X	X			X
Northern anchovy	X	X		X	X	
Pacific sardine	X	X		X	X	
Pacific mackerel	X	X		X	X	
Jack mackerel					X	
Market squid	?	?	?		X	?
Salmon						
Coho salmon				X	X	
Chinook salmon			X	X	X	

Potential Adverse Effects of Proposed Project

The specific essential fish habitat discussed depends on the project location and the species present. The adverse effects discussed in the BA or BE can be referenced, and additional effects can be discussed here. Unless it is clear that the effects on an individual species are unique, it is not necessary to discuss the adverse effects on a species-by-species basis, as this would certainly be repetitive and would provide no additional information. Instead, discuss the project's effects on EFH generally. However you should discuss the effects to salmonid, groundfish, and coastal pelagic EFH separately.

Adverse Effects on Essential Fish Habitat for Salmonids

Describe project effects on salmonid EFH.

Adverse Effects on Essential Fish Habitat for Ground Fishes

Describe project effects on ground fish EFH.

Adverse Effects on Essential Fish Habitat for Coastal Pelagic Species

Describe project effects on coastal pelagic EFH.

Essential Fish Habitat Conservation Measures

Describe the conservation measures incorporated into the project to minimize potential adverse effects on EFH. If these measures have already been described, refer to that description. An example follows:

The following measures will be implemented to minimize the potential adverse effects on designated EFH described above:

- Conservation measure 1
- Conservation measure 2
- etc.

Conclusion and Effect Determination

Summarize the potential effect that the project will have on EFH. This takes into account the conservation measures proposed as part of the project that were described above. [A determination of *may adversely effect* should be made if the action results in the reduction of quantity or quality of EFH. Otherwise, a determination of *will not adversely effect* or *no adverse effect* is appropriate.]

Essential Fish Habitat References

Listed below for convenience are the references containing the descriptions and definitions of essential fish habitat, provided by NOAA Fisheries and the Pacific

Fisheries Management Council. The specific references to be cited in each project EFH assessment depend on the fishery groups (ground fishes, coastal pelagics, and salmonids) present in the project action area.

Casillas, E., L. Crockett, Y. deReynier, J. Glock, M. Helvey, B. Meyer, C. Schmitt, M. Yoklavich, A. Bailey, B. Chao, B. Johnson, and T. Pepperell. 1998. Essential Fish Habitat, West Coast Groundfish—Appendix. National Marine Fisheries Service. 778 pp.

PFMC. 1998a. The Coastal Pelagic Species Fishery Management Plan: Amendment 8. Pacific Fishery Management Council.

PFMC. 1998b. Final Environmental Assessment/Regulatory Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan. Pacific Fishery Management Council.

PFMC. 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts, and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council.

17.0 Stormwater Impact Assessment

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17.0 Stormwater Impact Assessment

Chapter Summary

As part of a biological assessment, WSDOT assesses the environmental effects of stormwater and the construction of stormwater best management practices (BMPs) on the project site. This chapter provides background information on stormwater management as it relates to highway projects (Section 17.1), guidance to determine and quantify these effects to water quality and quantity (Section 17.2), guidance on analyzing water quality effects stemming from development or land use change that can be linked to transportation projects (Section 17.3), and a list of online resources (Section 17.4). This chapter provides an overview of the WSDOT *Highway Runoff Manual* but does not address the selection of BMPs that are incorporated into the project plans (Section 17.1.1). The selection process is outlined in the WSDOT *Highway Runoff Manual.*

The chapter also summarizes the BMP types identified in the WSDOT *Highway Runoff Manual* so that biologists who are writing BAs can be more familiar with stormwater treatment facilities (Section 17.1.2). BMPs for runoff treatment are described in Section 17.1.2.3, and BMPs for stormwater flow control are described in Section 17.1.2.4. This section describes the importance of maintenance of BMPs to ensure they function properly (Section 17.1.2.1) and describes design flows and volumes (Section 17.1.2.2).

Instructions are provided for incorporating a stormwater analysis into the BA in a stepwise fashion (Section 17.2), including:

- Step 1: Obtaining the Endangered Species Act Stormwater Design Checklist (Section 17.2.1)
- Step 2: Incorporating information about the selected BMPs into the project description (Section 17.2.2)
- Step 3: Incorporating stormwater effects into the action area analysis (Section 17.2.3)
- Step 4: Determining species use and presence of critical habitat within the action area (Section 17.2.4)
- Step 5: Describing existing environmental conditions (Section 17.2.5)
- Step 6: Determining the extent of stormwater related effects to species and critical habitat – separate protocols for analyzing flow impacts and for analyzing water quality impacts in Eastern (Section 17.2.6.1) and Western Washington (Section 17.2.6.2) are described
- Step 7: Examining site-specific conditions that may affect stormwater-related effects but that are not reflected in modeling results (Section 17.2.7)

- Step 8: Double-checking the action area to ensure it incorporates all anticipated physical, biological, chemical effects (Section 17.2.8)
- Step 9: Pulling it all together: completing a comprehensive exposure response analysis for listed species and critical habitat (Section 17.2.9)
- Step 10: Finally, guidance is provided to quantify stormwater-related effects and make effect determinations in accordance with Section 7 of the ESA (Section 17.2.10)

Online resources for stormwater are provided in Section 17.4.

It is important to understand that not all projects will have stormwater effects on listed species or proposed or designated critical habitat due to location, absence of the species and habitats, or a project type that does not have new impervious surface and does not alter flow conditions. These project types need not complete a detailed stormwater analysis. However, these projects are expected to include a brief stormwater discussion as part of the project description and to document project effects (or lack thereof) on listed species along with supporting rationale in the effects analysis section of the BA. These types of projects may include: bridge seismic retrofits, ACP overlays, guardrail installations, project areas that are located a great distance from surface water, and projects that can infiltrate all runoff due to highly permeable soils.

17.1 Background Information on Stormwater Management for Highway Projects

Projects that construct new impervious surface may affect the quantity and quality of runoff originating from within the project area for the following reasons:

- Impervious surface prevents rainwater from infiltrating, can reduce groundwater recharge, and affect base flows of nearby surface water.
- Conversion of pervious surfaces (e.g., vegetated areas) to impervious surface can result in increased surface runoff. Changes to the pattern or rate of surface runoff may increase peak flows in receiving waters.
- The presence of impervious surface provides a platform that collects settled air pollutants, contaminants from vehicles and road maintenance activities, and sediment from the surrounding environment. These pollutants are mobile and become a part of the runoff that moves through the watershed.

WSDOT incorporates stormwater BMPs into the project design to manage the quality and quantity of runoff. Stormwater BMPs are designed to reduce pollution and attenuate peak flows and volumes associated with stormwater runoff. Some temporary BMPs are used only during the construction phase of a project. Permanent BMPs are used to control and treat runoff generated by continued operation of the highway, park-and-ride lot, rest area, ferry holding area, or other transportation project site. Properly designed, constructed and maintained stormwater BMPs can provide important benefits. However, stormwater BMPs do not eliminate all stormwater impacts. Projects that construct new impervious surface need to address the potential short- and long-term effects on species and habitat listed or designated under the Endangered Species Act (ESA).

Project biologists must evaluate all of the short- and long-term stormwater effects associated with a project. These effects include:

- Changes in flows (peak, base, duration)
  - Direct effects associated with changes in flow or local hydrology
  - Indirect effects associated with changes in flow or local hydrology
- Changes in pollutant loads and concentrations
  - Direct effects associated with changes in pollutant loads and concentrations
  - Indirect effects associated with changes in pollutant loads and concentrations
- Temporary impacts that occur during the construction of stormwater BMPs and conveyance facilities
  - Direct effects associated with installation or construction of stormwater treatment elements (BMPs, conveyance, ditches, outfalls, etc.)
- Permanent impacts from the physical presence of stormwater treatment elements (BMPs, conveyance, ditches, outfalls, etc.).
  - Indirect effects associated with installation or construction of stormwater treatment elements (BMPs, conveyance, ditches, outfalls, etc.)

17.1.1 Summary of WSDOT *Highway Runoff Manual*

The WSDOT *Highway Runoff Manual* provides uniform technical guidance and establishes minimum requirements for avoiding and mitigating water resource impacts associated with the development of state-owned and operated transportation infrastructure systems, and for reducing water resource impacts associated with redevelopment of those facilities.

The *Highway Runoff Manual* is used by project stormwater engineers and designers as guidance to evaluate site conditions, to help characterize the stormwater treatment needs for proposed projects and to identify and appropriately size BMPs to provide adequate treatment and flow control for stormwater runoff.

The *Highway Runoff Manual* meets the level of stormwater management established by the Washington Department of Ecology to achieve compliance with federal and state water quality regulations. These regulations require stormwater treatment systems to be properly designed, constructed, maintained, and operated to achieve the following goals:

- Prevent pollution of state waters, protect water quality, and comply with state water quality standards
- Satisfy state requirements for all known, available, and reasonable methods of prevention, control, and treatment (AKART) of wastes prior to discharge to waters of the state
- Satisfy the federal technology-based treatment requirements under 40 CFR 125.3
- Prevent further water quality impairment resulting from new stormwater discharges and make reasonable progress in addressing existing sources of water quality impairment.

The *Highway Runoff Manual* reflects the best available science in stormwater management to ensure that WSDOT projects protect environmental functions and values. WSDOT considers this manual to include all known, available, and reasonable methods of prevention, control, and treatment for stormwater runoff discharges, consistent with state and federal law.

To uphold federal and state wetland regulations, WSDOT strives to maintain the extent, quality and existing hydrology of wetlands to which its stormwater facilities discharge. WSDOT attempts to avoid discharges to wetlands that provide habitat for listed species. However, some wetlands are dependent upon the inputs from roadway runoff to maintain their hydrologic characteristics so stormwater-related flows to these systems are maintained.

Projects that design, construct and maintain stormwater BMPs in a manner consistent with the *Highway Runoff Manual* are considered by the Department of Ecology to have satisfied the above requirements. However, as projects undertake the ESA consultation process, additional treatment and analysis may be required in order to adequately assess, minimize or avoid impacts to listed species.

A summary of BMP types in the *Highway Runoff Manual* is provided in the section below. This information is provided so that biologists will better understand the information they are provided by project engineers.

17.1.2 Summary of WSDOT *Highway Runoff Manual* Stormwater BMPs

This section provides background information to biologists who are writing BAs to familiarize them with stormwater management concepts. The section describes the design flows and volumes (Section 17.1.2.2), and also the function and effectiveness of the BMPs included in the *Highway Runoff Manual*. There are a total of 16 BMPs for runoff treatment (water quality – Section 17.1.2.3) and 9 BMPs for flow control (water quantity – Section 17.1.2.4) in the *Highway Runoff Manual*. The experimental and low-preference BMPs described herein may be used in unusual situations with project-specific approval. For further information on stormwater BMPs, the *Highway Runoff Manual* (or other documents referenced in the following sections) should be consulted. This manual can be found at: <http://www.wsdot.wa.gov/Environment/WaterQuality/default.htm>.

17.1.2.1 Maintenance of BMPs

The effectiveness of runoff treatment and flow control BMPs is highly dependent on adequate and frequent maintenance. Lack of maintenance can result in excessive sediment buildup in ponds, which can reduce storage volume; die-off of vegetation in vegetated BMPs, leading to reduced pollutant uptake and filtration; and clogging of outlets and orifices, affecting hydraulic function. BMP effectiveness claims and assumptions are only applicable to maintained facilities. Maintenance standards for WSDOT BMPs are described in the *Highway Runoff Manual*. For ESA-related consultations, it is assumed that stormwater BMPs and conveyance and discharge structures will be maintained as described in the *Highway Runoff Manual.*

17.1.2.2 BMP Design Flows and Volumes

Runoff treatment BMPs are designed using runoff volume (wet pool facilities) or discharge rates. Flow control BMPs are designed based on peak discharge rates and durations. In western Washington, wet pool runoff treatment BMPs (e.g., wet ponds, stormwater treatment wetlands) are designed with a wet pool volume that is equal to or greater than the runoff volume from 91st percentile, 24-hour storm event. In eastern Washington, wet pool BMPs are designed with a wet pool volume that is equal to the runoff volume from a 6-month, long duration storm event. In western Washington, discharge-based runoff treatment BMPs (e.g., biofiltration swales, media filters) located upstream of detention facilities (if present) are designed to treat the flow rate at or below which 91 percent of the annual runoff volume. In eastern Washington, discharge-based runoff treatment BMPs upstream of detention facilities (if present) are designed to treat the peak runoff discharge from a 6-month, short duration storm event. If discharge-based runoff treatment BMPs are located downstream of a detention facility in either western or eastern Washington, they are designed to treat the 2-year release rate from the facility.

Flow control BMPs are designed to meet the following criteria:

- In western Washington, stormwater discharges must match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2-year peak flow up to the full 50-year peak flow.

- In eastern Washington, limit the peak release rate of the postdeveloped 2-year runoff volume to 50 percent of the predeveloped 2-year peak and maintain the predeveloped 25-year peak runoff rate.

BMPs can be configured as **on-line** BMPs, in which all runoff is conveyed through the facility, or as **off-line** facilities, in which flows exceeding the design discharge rate bypass the BMP. All volume-based (wet pool) runoff treatment BMPs and flow control BMPs are designed as on-line facilities. Discharge-based runoff treatment BMPs can be designed as off-line or on-line facilities. However, on-line discharge-based runoff treatment BMPs in western Washington will be larger so that they can meet the 91 percent runoff volume treatment goal. This is because on-line discharge-based BMPs do not effectively treat runoff when flows exceed the design flow. Off-line BMPs do treat the design flow as excess flows bypass the facility.

17.1.2.3 BMPs for Runoff Treatment

Runoff treatment BMPs are organized into four runoff treatment targets:

1. **Basic Treatment** BMPs are designed to effectively remove suspended solids from stormwater (80 percent removal) through physical treatment processes (sedimentation/settling, filtration). The basic treatment target applies to most projects that generate and discharge stormwater runoff to surface waters.

2. **Enhanced Treatment** BMPs are designed to remove dissolved metals from stormwater through enhanced treatment mechanisms (chemical and biological processes). Enhanced treatment BMPs also remove suspended solids from stormwater as or more effectively than basic treatment BMPs. The enhanced treatment target applies to runoff from higher-traffic roadways in some cases.

3. **Oil Control** BMPs are designed to remove non-polar petroleum products from stormwater through flotation and trapping. The oil control treatment target applies to runoff generated in high-use intersections, rest areas, and maintenance facilities statewide; and in higher-traffic roadways in eastern Washington.

4. **Phosphorus Control** BMPs are designed to remove phosphorus from stormwater (50 percent removal) through enhanced sedimentation, as well as chemical and biological processes. The phosphorus control treatment target applies to runoff generated in areas that discharge to phosphorus-sensitive surface water bodies.

Multiple treatment targets may apply to individual threshold discharge areas (TDAs) and to different TDAs within a project. The *Highway Runoff Manual* defines TDAs as follows: *An on-site area draining to a single natural discharge location or multiple natural discharge locations that combine within 1/4 mile downstream (as determined by the shortest flow path)*.

The following runoff BMP types are described in the subsections below:

- Infiltration BMPs
- Dispersion BMPs
- Biofiltration BMPs
- Wet Pool BMPs
- Media Filtration BMPs
- Oil Control BMPs

Infiltration BMPs

Infiltration is the discharge of stormwater to shallow groundwater through porous soils, and infiltration BMPs treat stormwater through filtration and chemical soil processes (adsorption and ion exchange). The *Highway Runoff Manual* includes the following four infiltration BMPs:

1. Bioinfiltration pond (eastern Washington only)
2. Infiltration pond
3. Infiltration trench
4. Infiltration vault

Along with dispersion (described in the section below), infiltration is a preferred method of treatment, offering the highest level of pollutant removal. In order to use infiltration for runoff treatment, native soils must meet (or be amended to meet) specific permeability and chemical criteria. In addition to treatment, infiltration BMPs provide effective flow control by reducing the volume and peak surface water discharge rates. Another important advantage to using infiltration is that it recharges the ground water, thereby helping to maintain summertime base flows in streams and reducing stream temperature naturally. These are important factors in maintaining a healthy habitat for instream biota.

Infiltration facilities must be preceded by a presettling basin to remove most of the sediment particles that would otherwise reduce the infiltrative capacity of the soil. Infiltration strategies intended to meet runoff treatment goals may be challenging for many project locations in western Washington due to strict soil and water table requirements. Eastern Washington generally offers more opportunities for the use of infiltration BMPs.

Bioinfiltration ponds are vegetated ponds that store and infiltrate stormwater while also removing pollutants through vegetative uptake. This BMP, developed and used more commonly in eastern Washington, functions as both a biofiltration BMP and an infiltration BMP and can meet basic, enhanced and oil control treatment targets. Bioinfiltration ponds can only be applied in eastern Washington, and because of limitations on ponding depth they require a large footprint to meet flow control requirements.

Infiltration ponds are open-water facilities that store and infiltrate stormwater vertically through the base. Implementation of infiltration ponds can be challenging due to their large space requirements. Because treated runoff is removed from the surface water system, specific treatment targets are not applicable to this BMP.

Infiltration trenches (also called infiltration galleries) are gravel-filled trenches designed to store and infiltrate stormwater. They commonly include perforated pipe for conveyance of stormwater throughout the trench. Limitations of infiltration trenches are similar to those of infiltration ponds, but they can be configured to more easily fit into constrained sites and linear roadway corridors. Below-ground infiltration BMPs such as infiltration trenches may also be subject to underground injection control (UIC) rules.

Infiltration vaults are below-ground storage facilities (tanks, concrete vaults) with perforations or open bases, allowing stormwater to infiltrate. Limitations of infiltration vaults are similar to those of infiltration ponds, but they can fit more constrained sites – even located beneath pavement. An additional challenge for infiltration vaults is the maintenance access challenges that below-ground facilities pose – potentially requiring confined-space entry by maintenance personnel. Like infiltration trenches, infiltration vaults may be subject to underground injection control (UIC) rules.

Dispersion BMPs

Dispersion BMPs treat stormwater by vegetative and soil filtration and shallow infiltration of sheet flow discharge. The two dispersion BMPs included in the *Highway Runoff Manual* are:

1. Natural dispersion
2. Engineered dispersion

Natural dispersion is sheet flow discharge of runoff into a preserved, naturally vegetated area. It is perhaps the single most effective way of mitigating the effects of highway runoff in nonurban areas. Natural dispersion can meet the basic and enhanced treatment targets by making use of the pollutant-removal capacity of the existing naturally vegetated area. The naturally vegetated area must have topography, soil, and vegetation characteristics that provide for the removal of pollutants.

Natural dispersion has several notable benefits: it can be very cost-effective, it maintains and preserves the natural functions, and it reduces the possibility of further impacts on the natural areas adjacent to constructed treatment facilities. In most cases this method not only meets the requirements for runoff treatment but also provides flow control. However, if channelized drainage features are near the runoff areas requiring treatment, then engineered dispersion or other types of engineered solutions may be more appropriate.

Despite the benefits described above, natural dispersion requires a substantial area of land adjacent to the runoff source area. This area must be protected from future development with a conservation easement or other measure. Because of this, applicability of this BMP is very limited for roadway/highway projects.

Engineered dispersion is sheet flow dispersion of concentrated stormwater (using flow spreaders). This BMP uses the same removal processes as natural dispersion, and can also meet basic and enhanced treatment targets. For engineered dispersion, a manmade conveyance system directs concentrated runoff to the dispersion area (via storm sewer pipe or ditch, for example). The concentrated flow is dispersed at the end of the conveyance system to mimic sheet-flow into the dispersion area. Engineered dispersion techniques coupled with compost-amended soils and additional vegetation enhance the modified area. These upgrades help to ensure that the dispersion area has the capacity and ability to infiltrate surface runoff.

The limitations described under natural dispersion above also apply to engineered dispersion.

Biofiltration BMPs

Biofiltration BMPs treat stormwater through vegetative and soil filtration and uptake. The *Highway Runoff Manual* includes the following five biofiltration BMPs:

1. Vegetated filter strip – basic, narrow, and compost-amended
2. Biofiltration swale
3. Wet biofiltration swale
4. Continuous inflow biofiltration swale
5. Media filter drain (previously called ecology embankment)

Vegetated filter strips are gradually sloping areas adjacent to the roadway that treat runoff by maintaining sheet flow, reducing runoff velocities, filtering out sediment and other pollutants, and providing some infiltration into underlying soils. The flow can then be intercepted by a ditch or other conveyance system and routed to a flow control BMP or outfall. Vegetated filter strips can the meet basic treatment target, and are well suited for linear roadway projects where sheet flow can be maintained from the roadway surface (no curbs, gutters, or channelized drainage at the edge of pavement). In addition to the basic vegetated filter strip, there are two modifications to the vegetated filter strip BMP: the narrow area vegetated filter strip, and the compost-amended vegetated filter strip.

The **narrow-area vegetated filter strip** is similar to the basic vegetated filter strip, but is simpler to design. This BMP is limited to impervious flow paths of 30 feet or less, and also meets the basic treatment target.

The **compost-amended vegetated filter strip** (CAVFS) is an enhanced version of the basic vegetated filter strip. By incorporating compost amendment and subsurface gravel courses, CAVFS can meet basic, enhanced, phosphorus control, and oil control treatment targets.

Biofiltration swales are relatively wide (compared to conveyance ditches) vegetated channels that treat runoff by filtering concentrated flow through grassy vegetation with a shallow flow depth. The swale functions by slowing runoff velocities, filtering out sediment and other pollutants, and providing some infiltration into underlying soils. Biofiltration swales can meet the basic treatment target.

Biofiltration swales can also be integrated into the stormwater conveyance system, as they are typically designed as on-line BMPs (no bypass of flows exceeding design discharge). Existing roadside ditches may be good candidates for upgrading to biofiltration swales. Biofiltration swales are not recommended for use in arid climates. In semi-arid climates, drought-tolerant grasses should be specified.

The **wet biofiltration swale** is a variation of a basic biofiltration swale that is applicable where the longitudinal slope is slight, the water table is high, or continuous low base flow tends to cause saturated soil conditions. The wet biofiltration swale typically uses different vegetation that is suitable for saturated conditions, and meets the basic treatment target.

The **continuous inflow biofiltration swale** is another variation of the biofiltration swale that is applicable where water enters a channel continuously along the side slope rather than being concentrated at the upstream end. This BMP also meets the basic treatment target.

The **media filter drain** (previously called ecology embankment) is a BMP that incorporates a treatment train of pollutant removal mechanisms immediately adjacent to a raised roadway and meets the basic, enhanced, and phosphorus control treatment targets. Unconcentrated runoff enters the media filter drain through a narrow grass strip, and is filtered through a shallow subsurface media consisting of mineral aggregate, dolomite, gypsum, and perlite. The media filter drain also provides infiltration through the base of the media gallery, but is not approved for use as a flow control BMP. The media filter drain integrates soil amendments in the grass strip, providing significant pollution reduction and flow attenuation. Its application is limited to raised highways located in relatively flat terrain. This BMP can often be constructed with little or no additional right-of-way, making it a cost-effective solution to managing highway runoff.

Wet Pool BMPs

Wet pool BMPs treat runoff by reducing velocities and settling particulate material. Vegetated portions of wet pool BMPs also treat runoff with vegetative and soil filtration and uptake. The *Highway Runoff Manual* includes the following four BMPs:

1. Wet pond
2. Combined wet/detention pond
3. Constructed stormwater treatment wetland
4. Combined stormwater treatment wetland/detention pond

In addition to the BMPs included in the *Highway Runoff Manual*, underground **wet vaults** are sometimes used for runoff treatment when site area constraints do not allow for a large surface pond facility. Wet vaults are the least preferred method of runoff treatment, and are not included in the *Highway Runoff Manual*.

A **wet pond** is a constructed basin containing a permanent pool of water throughout the wet season. Wet ponds function primarily by settling suspended solids, and can meet the basic treatment target. Wet ponds can also be sized larger to meet the phosphorus control treatment target. Biological action of plants and bacteria provides some additional treatment. Wet ponds are usually more effective and efficient when constructed using multiple cells (i.e., a series of individual smaller basins), where coarser sediments become trapped in the first cell, or forebay.

Because the function of a wet pond depends upon maintaining a permanent pool of water to provide treatment, wet ponds are generally not recommended for use in arid or semi-arid climates. Cold-climate applications can be problematic, and additional modifications must be considered. The spring snowmelt may have a high pollutant load and produce a larger runoff volume to be treated. In addition, cold winters may cause freezing of the permanent pool or freezing at inlets and outlets. High runoff salt concentrations resulting from road salting may affect pond vegetation, and sediment loads from road sanding may quickly reduce pond capacity.

Wet ponds can be configured to provide flow control by adding **detention** volume (live storage) above the permanent wet pool. This is called a **combined wet/detention pond**.

Constructed stormwater treatment wetlands are similar to wet ponds, but are configured to include shallower zones with substantial vegetation for enhanced filtration and uptake. This BMP can meet basic and enhanced treatment targets. Sediment and associated pollutants are removed in the first cell of the system via settling. The processes of settling, biofiltration, biodegradation, and bioaccumulation provide additional treatment in the subsequent cell or cells. In general, constructed stormwater treatment wetlands could be incorporated into drainage designs wherever water can be collected and conveyed to a maintainable artificial basin.

Constructed stormwater treatment wetlands offer a suitable alternative to wet ponds or biofiltration swales and can also provide treatment for dissolved metals. The landscape context for stormwater wetland placement must be appropriate for creation of an artificial wetland (i.e., ground water, soils, and surrounding vegetation). Natural wetlands cannot be used for stormwater treatment purposes.

Very few constructed stormwater wetlands exist in Washington state. However, constructed stormwater wetlands can be a preferred stormwater management option over other surface treatment and flow control facilities. In general, this option is a more aesthetically appealing alternative to ponds.

Constructed stormwater treatment wetlands can be configured to provide flow control by adding **detention** volume (live storage) above the permanent wet pool. This is called a **combined stormwater treatment wetland/detention pond**.

Media Filtration BMPs

Media filtration BMPs treat stormwater through physical filtration (straining) of particulates when using inert media, as well as chemical processes (e.g., adsorption, ion exchange) when media are reactive. The *Highway Runoff Manual* does not include any media filtration BMPs. However, some media filtration BMPs that can be used with approval from the regional WSDOT Hydraulics Office and Maintenance Supervisor include:

- Sand filter basin
- Linear sand filter
- Sand filter vault
- Proprietary canister filters

Media filtration BMPs capture and temporarily store stormwater runoff and then slowly filter it through a bed of granular media such as sand, organic matter, perlite, soil, or combinations of organic and inorganic materials. In this process, stormwater passes through the filter medium, and particulate materials either accumulate on the surface of the medium (which strains surficial solids) or are removed by deep-bed filtration. Silica sands are relatively inert materials for sorption and ion exchange. However, sands that contain significant quantities of calcitic lime, iron, magnesium, or humic materials can remove soluble contaminants such as heavy metals or pesticides through precipitation, sorption, or ion exchange. For more information on media filtration BMPs, see the *Stormwater Management Manual for Western Washington* (Ecology 2005).

The **sand filter basin** is a pond-type open water facility where water is stored and travels vertically through the media filter in the bed of the basin. Sand filter basins require a substantial amount of area, and like all media filtration BMPs require intensive maintenance. In general, surface sand filters are not recommended where high sediment loads are expected, because sediments readily clog the filter. Sodding the surface of the filter bed can reduce clogging to some degree. This treatment method is not reliable in cold climates because water is unable to penetrate the filter bed if it becomes frozen.

The **linear sand filter** is a below-ground sand filter configuration that can be installed at the edge of impervious areas, and can fit more constrained sites than the sand filter basin.

The **sand filter vault** is a below-ground facility incorporating a settling chamber and a filtration bed. While the underground configuration allows for application in more constrained sites than the above-ground sand filter basin, the already intensive maintenance requirements are more challenging due to access constraints.

Proprietary **canister filters** (including the CONTECH StormFilter and the CONTECH MFS) are vault-style facilities that provide filtration of stormwater through replaceable cartridge cylinders filled with filter media. These BMPs can configured as above-ground or below-ground vaults, and the media can be designed for specific treatment needs.

Media filtration BMPs are <u>not</u> included in the *Highway Runoff Manual*.

Oil Control BMPs

BMPs that have the primary function of removing oil from stormwater include the following:

- Oil containment boom
- Baffle-type oil/water separator
- Coalescing plate separator
- Catch basin inserts

Of these BMPs, only the oil containment boom is included in the *Highway Runoff Manual*. The baffle-type oil/water separator and the coalescing plate separator are not included in the *Highway Runoff Manual* because of maintenance challenges associated with them. The following other BMPs can perform the oil control function in addition to meeting other runoff treatment functions:

- Bioinfiltration pond (eastern Washington only; see Infiltration BMPs section above)
- Compost-amended vegetated filter strip (see Biofiltration BMPs section above)

Oil containment booms contain sorptive material that captures oil and grease at the molecular level. These booms are applied to open water stormwater treatment BMPs including wet ponds, and capture floating petroleum product. An oil control BMP should be placed as close to the source as possible but protected from sediment. Sorptive oil containment booms can be placed on top of the water in sediment control devices and can be used in ponds and vaults.

Baffle-type oil/water separators and **coalescing plate separators** are below-ground vault facilities that collect oil and grease by trapping the floating material. These BMPs are configured as below-ground vault-type facilities, are expensive to maintain, and usually pose safety hazards for maintenance workers who must work in confined spaces or out in roadway traffic. Moreover, it is difficult to verify whether these BMPs are working effectively. Baffle oil/water separators and coalescing plate devices should be installed downstream of primary sediment control devices and can be used at pond outlets. For more information on these oil control BMPs, see the *Stormwater Management Manual for Western Washington* (Ecology 2005).

Catch basin inserts with sorptive media are appropriate only for the very lowest sediment yield areas because they can easily plug and cause roadway flooding. Catch basin inserts must be maintained (inspected and replaced) frequently to effectively remove pollutants from stormwater.

Runoff Treatment Trains

Runoff treatment is often achieved using a series of BMPs rather than a single facility. However, the *Highway Runoff Manual* does not recognize treatment trains as a viable approach to meeting enhanced or phosphorus control treatment targets without project-specific approval.

Treatment trains often involve a basic treatment BMP such as wet pool or biofiltration followed by a media filtration BMP. This provides settling of the coarser solid material in stormwater before additional removal of finer material can be achieved. By removing solids prior to filtration the rate at which the media filter clogs can be reduced, extending the maintenance cycle of the facility.

See Table 17-1 on the following page for a list of runoff treatment BMPs, their treatment type (e.g., basic treatment, phosphorous control), and regional applicability.

17.1.2.4 BMPs for Stormwater Flow Control

Stormwater flow control BMPs are designed to control the flow rate or the volume of runoff leaving a developed site. The primary flow control mechanisms are dispersion, infiltration, and detention. Increased peak flows and increased durations of sustained high flows can cause downstream damage due to flooding, erosion, and scour, as well as degradation of water quality and instream habitat through channel and stream bank erosion. The following provides an overview of the most commonly used flow control BMPs for highway application.

Table 17-1. Runoff treatment Best Management Practices.

BMP #	Runoff Treatment BMP	Treatment Type				Regional Applicability	
		Basic Treatment	Enhanced Treatment	Phosphorus Control	Oil Control	Western Washington	Eastern Washington
IN.01	Bioinfiltration Ponds	X	X		X		X
IN.02	Infiltration Ponds	*	*	*		X	X
IN.03	Infiltration Trenches	*	*	*		X	X
IN.04	Infiltration Vaults	*	*	*		X	X
FC.01	Natural Dispersion	X	X				
FC.02	Engineered Dispersion	X	X				
RT.02	Basic Vegetated Filter Strip	X				X	X
RT.02	Narrow Area Vegetated Filter Strip	X				X	X
RT.02	Compost-Amended Vegetated Filter Strip	X	X	X	X	X	X
RT.04	Biofiltration Swale	X				X	X
RT.05	Wet Biofiltration Swale	X				X	X
RT.06	Continuous Inflow Biofiltration Swale	X				X	X
RT.07	Media Filter Drain	X	X	X		X	X
RT.12	Wet Pond (basic)	X				X	X
RT.12	Wet Pond (large)	X		X		X	X
CO.01	Combined Wet/Detention Pond (basic)	X				X	X
CO.01	Combined Wet/Detention Pond (large)	X		X		X	X
RT.13	Constructed Stormwater treatment wetlands	X	X			X	X
CO.02	Combined stormwater treatment wetland/ detention pond	X	X			X	X
RT.14	Sand Filter Basin (basic)	X				CAT 1	CAT 1
RT.14	Sand Filter Basin (large)	X	X	X		CAT 1	CAT 1
RT.15	Linear Sand Filter (basic)	X			X	CAT 1	CAT 1
RT.15	Linear Sand Filter (large)	X	X		X	CAT 1	CAT 1
RT.16	Sand Filter Vault (basic)	X				CAT 1	CAT 1
RT.16	Sand Filter Vault (large)	X		X		CAT 1	CAT 1

X = BMP meets this treatment type
* = BMP does not discharge to surface water – runoff treatment goals are not applicable.
CAT 1 = this BMP is approved by Ecology, but are not included in the Highway Runoff Manual because they are not considered viable options for treatment of highway runoff. Project-specific approval is needed to use these BMPs on WSDOT projects.

Infiltration BMPs

Infiltration BMPs reduce the volume of runoff discharged to surface waters from a site. If surface discharge is not completely eliminated, infiltration BMPs can reduce the flow rates and the durations of sustained high flows. The *Highway Runoff Manual* includes the following six infiltration BMPs for flow control:

1. Bioinfiltration pond (eastern Washington only)
2. Infiltration pond
3. Infiltration trench
4. Infiltration vault
5. Drywell
6. Permeable pavement systems

Bioinfiltration ponds, **infiltration ponds**, **infiltration trenches**, and **infiltration vaults** are described in Section 17.1.2.3 BMPs for Stormwater Runoff Treatment. **Bioinfiltration ponds** are restricted to eastern Washington, and may not be able to fully meet flow control criteria.

Drywells, which function similar to infiltration trenches, are subsurface concrete structures that convey stormwater runoff into the soil matrix. Drywells can be used to meet flow control requirements, but do not provide runoff treatment. Uncontaminated or properly treated stormwater must be discharged to drywells in accordance with the Ecology Underground Injection Control (UIC) program.

Permeable pavement systems are alternative paving materials that allow infiltration of rainfall directly to the pavement base. Permeable pavement types include permeable concrete, permeable asphalt, and paver systems. Permeable pavement cannot be used alone to meet flow control criteria, but can reduce the size of downstream BMPs.

Dispersion BMPs

Dispersion BMPs control flows through shallow infiltration, which reduces the volume of surface runoff. Sheet flow in the dispersion area increases the runoff travel time, decreasing flow rates. The *Highway Runoff Manual* includes the following two dispersion BMPs for flow control:

1. Natural dispersion
2. Engineered dispersion

Natural dispersion and engineered dispersion are described in Section 17.1.2.3, BMPs for Stormwater Runoff Treatment.

Detention BMPs

Detention BMPs control flows by storing runoff and releasing it at reduced rates. The three detention BMPs included in the *Highway Runoff Manual* are the following:

1. Detention pond
2. Detention vault
3. Detention tank

Detention ponds are open-water basins that store runoff and release it at reduced rates. These BMPs can be configured as a dry pond to control flow only, or it can be combined with a wet pond or constructed stormwater treatment wetland to also provide runoff treatment within the same footprint. These combined facilities, called combined wet/detention ponds and combined stormwater wetland/detention ponds, are described in Section 17.1.2.3, BMPs for Stormwater Runoff Treatment. Detention ponds generally require a substantial area of land.

Detention vaults and **detention tanks** are below-ground storage facilities that are commonly used for projects that have limited space and thus cannot accommodate a pond. Although vaults and tanks require minimal right-of-way, they are difficult to maintain due to poor accessibility and effort required for visual inspection. Typically, the increased construction and maintenance expenses quickly offset any initial cost benefits derived from smaller right-of-way purchases. Consequently, underground detention is the least preferred method of flow control.

17.2 Stepping through a Stormwater Analysis

The project biologist should integrate the discussion about stormwater and the stormwater BMPs into the various sections of the BA, including project description, existing environmental conditions, action area, effects analysis, and effect determinations. Other sections of the BA such as the species and critical habitat section contain relevant information that will be incorporated into the stormwater analysis. The species and critical habitat section provides information on the presence and timing of various life stages of species within the action area that will be used to help to identify the potential for exposure, and limit the stormwater modeling to those months when each of the species may be present. Some species and lifestages exhibit distinct seasonality whereas others may be present year-round. It is important to note that stormwater discharges generally cause long-term effects to receiving waterbody conditions. Discharges may be episodic in nature, but occur in perpetuity. The analysis of effects must take these persistent indirect effects into account in order to understand long-term project effects on habitat, habitat forming-processes and the functionality of habitat characteristics or existing environmental conditions. The potential exposure(s) of individual fish to these discharges over time hinges upon the life history strategy and timing of various life stages of species within the action area.

The following sections describe the appropriate documentation of stormwater elements and impacts within the BA and step through the process of evaluating stormwater and stormwater BMP effects on species and habitat for eastern and western Washington. Ten steps are outlined below for completing a stormwater analysis:

1. Step 1: Obtain the Endangered Species Act Stormwater Design Checklist (Section 17.2.1)
2. Step 2: Incorporate information about the selected BMPs into the project description (Section 17.2.2)
3. Step 3: Incorporate stormwater effects into the action area analysis (Section 17.2.3)
4. Step 4: Determine species use and presence of critical habitat within the action area (Section 17.2.4)
5. Step 5: Describe existing environmental conditions (Section 17.2.5)
6. Step 6: Determine the extent of stormwater related effects to species and critical habitat – separate protocols for analyzing flow impacts and for analyzing water quality impacts in Eastern (Section 17.2.6.1) and Western Washington (Section 17.2.6.2) are described
7. Step 7: Examine site-specific conditions that may affect stormwater-related effects but that are not reflected in modeling results (Section 17.2.7)
8. Step 8: Re-evaluate the action area to ensure it incorporates all anticipated physical, biological, chemical effects (Section 17.2.8)
9. Step 9: Pull it all together: complete a comprehensive exposure-response analysis for listed species and critical habitat (Section 17.2.9)
10. Step 10: Quantify stormwater-related effects and make effect determinations in accordance with Section 7 of the ESA (Section 17.2.10).

17.2.1 Step 1: Obtain the Endangered Species Act Stormwater Design Checklist and Review Project Plans

The project biologist describes stormwater management plans in the BA based on the information presented by the project engineer in the ESA stormwater design checklist and project plans. The project biologist should request the project engineer to fill out this checklist. Checklist templates (one for western Washington and one for eastern Washington) are available, along with other stormwater-related guidance, on WSDOT's Biological Assessment website at: <http://www.wsdot.wa.gov/Environment/Biology/BA/default.htm#Stormwater>.

The checklist breaks down the analysis of stormwater elements and impacts into areas draining to specific outfalls or into "threshold discharge areas" or TDAs. The *Highway Runoff Manual* defines TDAs as follows: *An on-site area draining to a single natural discharge location or multiple natural discharge locations that combine within 1/4 mile downstream (as determined by the shortest flow path).*

Project plans may also be useful in determining locations of proposed BMPs and outfalls. These locations must be known in order to assess environmental impacts of the BMPs themselves, and in order to accurately describe the proposed conveyance system how its configuration influences the potential for exposure. The project biologist should be prepared to ask for additional information during or before site visits, because the location of the displaced habitat must be identified in the field.

The completed checklist should not be attached to the BA; rather, the information summarized in the checklist should be incorporated into the appropriate sections of the BA.

17.2.2 Step 2: Incorporate Stormwater Information into the Project Description

17.2.2.1 Describe Proposed Changes to Impervious Surface

For each TDA, the project description should clearly convey how the project plans to change the existing configuration of impervious surface within the action area. For projects with numerous TDAs (i.e., more than 10 TDAs), information should be compiled and presented by waterbody or subwatershed.

Following is a list of information that should be included in the project description in the BA. The bulk of this information will be provided to the biologist via the ESA stormwater design checklist.

- Existing impervious surface area (acres) and treatment
  - Acreage receiving runoff treatment (basic; enhanced)
  - Acreage receiving no runoff treatment
  - Acreage receiving flow control prior to discharge
  - Acreage that infiltrates
  - Acreage receiving no flow control prior to discharge
- New impervious surface area (acres) and treatment
  - Total area of impervious surface draining into each proposed BMP (acres), outfall, and/or TDA.
  - Acreage that will receive runoff treatment (basic; enhanced)

    - Acreage that will receive no runoff treatment
    - Acreage that will receive flow control prior to discharge
    - Acreage that infiltrates
    - Acreage that will receive no flow control prior to discharge
- Impervious surface area to be removed (acres) as a result of the proposed project, and anticipated final condition of the areas where it will be removed
    - If a project will remove a large quantity of impervious surface in one or more TDAs, this should be clearly described in the BA and these changes should be quantified.
    - It may be appropriate to summarize "net new" impervious surface for these projects.
      Net New Impervious = Existing Impervious Area + New Impervious Area – Removed Impervious Area
- Existing impervious surface area that will be retrofitted as a result of the proposed project
    - Existing acreage retrofitted for runoff treatment
    - Existing acreage retrofitted for flow control
- Identify the receiving water(s) for flow or runoff from each BMP/outfall and/or TDA

The project description should also identify and describe all project-related changes or improvements to arterial or surface streets, frontage roads, and facilities.

Occasionally, transportation projects are associated with indirect effects in the form of urban and suburban development or changes in land use. As a result, the biologist may also need to characterize, more generally or qualitatively, the existing conditions within these additional areas. See CHAPTER 10, INDIRECT EFFECTS and Section 17.3for more information on completing this assessment.

17.2.2.2 Describe Proposed Stormwater BMPs

Linear projects such as highways often span several drainage basins or watersheds. As a result, different methods of stormwater treatment may be proposed for new impervious surfaces in different basins. The project engineer will likely refer to these different drainage areas as threshold discharge areas, and will summarize each TDA in the ESA stormwater design checklist prepared for the project. The project engineer will identify an appropriate BMP(s) for each TDA as necessary.

The project description should first fully describe existing runoff treatment and flow control BMPs. Name and describe the existing BMPs and indicate where they are located. The general information on BMPs provided earlier (Section 17.1.2) may inform this description. For projects using unconventional or experimental stormwater designs, BAs should clearly describe the proposed designs and how they will manage water quality or flow control. Also describe the existing stormwater conveyance system (i.e., is it an open like an unlined ditch or closed system like a pipe). When describing the conveyance system, clearly describe the distance to and/or conveyance channel characteristics from discharge points or outfalls to receiving waterbodies. Most of this information is supplied to the project biologist through the ESA stormwater design checklist. In summary:

- Describe the existing runoff treatment and flow control
- Describe the existing BMPs and their locations
- Describe the existing conveyance system and discharge points or outfalls

Next the project biologist should describe the proposed runoff treatment and flow control BMPs. If BMPs already exist at a project site and will not be altered or retrofitted in any way, this should be disclosed. Similarly, if removal, alteration, discontinuation or retrofitting of existing BMPs is proposed, this must be clearly explained in the project description. For new stormwater elements (BMPs, conveyance, outfalls, etc.), name and describe the proposed element and indicate where are they located, whether they are temporary or permanent, and how they are to be constructed (e.g., heavy equipment, or installed below the surface). For those stormwater elements that will partially or completely infiltrate runoff, the project engineer should provide the project biologist with justification for the anticipated level of infiltration to include in the project description of the BA. This justification must be included in the BA and should properly account for and address all of the following conditions:

- Seasonal variations in precipitation intensity and soil moisture
- Permeability of embankment fill and native soils
- Seasonal variations in depth to groundwater
- Vegetation present to provide evapotranspiration

The project biologist should work with the project engineer or designer to determine the anticipated infiltration rates and hydrologic performance of media filter drains (previously called ecology embankments) and compost-amended vegetated filter strips if these BMPs are components of a project's design. The performance of these BMPs will vary based upon site-specific designs and conditions. Monitoring data can provide the justification for assumed infiltration / water loss for other BMPs as well. The infiltration performance of these and other BMPs is being continually studied, and additional information may exist.

The project description should also explain how the proposed stormwater treatment is consistent with the *Highway Runoff Manual*, as represented by the project engineer in the ESA stormwater design checklist.

The project description should describe all stormwater elements (BMPs, conveyance, outfalls, etc.), construction activities associated with them, and related impact minimization measures. Examples include the excavation to install underground pipe that directs runoff from the roadway, construction of a swale that directs runoff from the roadway to the point of discharge, installation of a new outfall or discharge site, installation of riprap at the outlet pipe, or upgrades of an existing detention pond.

The project biologist should also accurately describe the proposed stormwater conveyance system (i.e., is it an open or closed system). When describing the conveyance system, provide the distance to and/or conveyance channel characteristics from discharge points or outfalls to receiving waterbodies. The project designer, via the ESA stormwater design checklist, will provide the biologist with this information.

The project description should characterize any flow control or runoff treatment exemptions the project qualifies for, in accordance with the *Highway Runoff Manual* and as presented in the ESA stormwater design checklist. If the project designer indicates that proposed stormwater BMPs will drain to any of the following waterbodies: **Puget Sound; Columbia River; and Lakes Sammamish, Silver, Union, Washington and Whatcom**, the biologist may not need to evaluate potential project effects to flow conditions or hydrology in the BA, because these are waterbodies considered flow exempt by USFWS and some of them are also considered flow exempt by NMFS.

- USFWS considers all the waterbodies listed above as flow exempt.
- NMFS only considers Puget Sound, the Columbia River, and Lake Washington flow exempt.

If the discharge is to an HRM exempt waterbody but not on the USFWS or NMFS list above, the project biologist should work with project designers and hydrologists to provide rationale as to why the flow effects are minor or work with project designers to analyze or model anticipated project effects on flow in the analysis of effects section of the BA. In summary:

- Describe the proposed runoff treatment and flow control
- Describe the proposed stormwater elements and their locations
- Justify incidental infiltration rates chosen for each proposed BMP or other stormwater element
    - Justification should be based on soil infiltration rates and abilities, presence or absence of a lining in the BMP or stormwater element, depth to ground water table, slope, and vegetation.

- Justification should properly account for and address seasonal variation and conditions in excess of the "design storm."

- Describe construction sequence, activities, and impact minimization measures for installing proposed stormwater elements
- Describe the proposed conveyance system and points of discharge (or outfalls) to receiving waterbodies
- Determine if runoff will discharge to waterbodies that are considered exempt (by the Services) from flow control requirements. If discharge is to a waterbody requiring flow control, coordinate with project designers to generate description of proposed flow control and assess effects to hydrology and flow conditions.

17.2.2.3 Quantify and Describe Habitat Impacts from Construction

The installation of several project elements, including stormwater components may require clearing of existing vegetation, in-water work to install an outfall, placement of rock to inhibit erosion or scour at the outfall location, alteration of the landscape or topography, or temporary disturbance to habitat while equipment is placed underground.

For each project element, it is important to quantify the extent of anticipated impacts, indicate whether the habitat displacement will be temporary or permanent, and provide enough detail to support later discussions of how the impacts may affect listed species and habitat. For projects with indirect effects, see CHAPTER 10, INDIRECT EFFECTS and Section 17.3 for guidance on determining the extent of impacts. Additional guidance for quantifying project impacts is discussed in detail in the ACTION AREA section (8.0) of this manual. The project description should quantify anticipated impacts on habitat in terms of:

- Approximate habitat area affected by the activity
- Location of impacts relative to sensitive habitats or species
- Habitat and/or vegetation type
- Terrain and how topography might enhance or inhibit potential project impacts extending to sensitive habitats or species

17.2.3 Step 3: Define the Action Area for the Proposed Project: Describe the Project's Stormwater Related Effects

The action area represents the geographic extent of anticipated physical, biological and chemical effects stemming from the proposed project. The direct and indirect effects from proposed stormwater elements constitute one component of this larger action area defined for the project in its entirety. The geographic extent of water quality effects and changes in flow or hydrology would define the stormwater-related component of the action area. Procedures for determining the extent of changes in flow or hydrology are described in the *Analyzing Effects on Flow and Duration* subsections of 17.2.6.1 (eastern Washington) and 17.2.6.2 (western Washington). In these same sections, the protocols for analyzing water quality effects are focused specifically on defining stormwater effects on listed species or proposed or designated critical habitat NOT on defining the geographic extent of water quality effects. In other words, the HI-RUN dilution subroutine does not predict the full extent of project-related effects on water quality relative to existing conditions. This is because the HI-RUN dilution model calculates the distances at which project stormwater run-off pollutant concentrations of dissolved metals will reach established behavioral thresholds for fish rather than reach existing conditions in the receiving waterbody. In order to estimate the full extent of water quality impacts to help delineate the action area, the biologist will need to work with project stormwater engineers and hydrologists to estimate the full extent of short- and long-term project-related water quality effects to the environment (turbidity, pollutant loading, pollutant concentrations, etc.). This area may be larger than the area identified in the water quality analysis described in subsections of 17.2.6.1 (eastern Washington) and 17.2.6.2 (western Washington).

Similarly, development(s) identified as an indirect effect of transportation projects may affect the size of the action area and therefore extent of the water quality and quantity impacts to be analyzed. Guidance for determining whether development can be attributed to a transportation project is provided in the INDIRECT EFFECTS (CHAPTER 10.0) of the manual, and for assessing water quality impacts generated by development and changes in land use is provided in Section 17.3 below.

17.2.4 Step 4: Determine Species Use and Presence of Critical Habitat within the Action Area and in the Vicinity of Each TDA Discharge Point or Outfall

Within receiving waters in the action area, and in the vicinity of the discharge location(s) or outfall(s) associated with each TDA, the biologist should determine the potential use and presence of species, the presence of suitable habitat for various life stages, critical habitat, and the related primary constituent elements. The biologist should identify the timing of various life stages to determine what months are of interest (a key input in the western Washington HI-RUN model) for the stormwater analysis for each species and to determine what the potential for exposure to stormwater discharge from project BMPs. Ultimately this information, coupled with information from steps 4, 5, and 6 will help the biologist assess how and where listed species or their habitat may be exposed to the project's stormwater-related effects. Step 9 (Section 17.2.9) describes the synthesis of this information as part of the exposure-response analysis.

17.2.5 Step 5: Describe Water Quality Indicators and Relevant Habitat Characteristics in the Existing Environmental Conditions

Existing environmental conditions in the project's receiving waters may influence the type of analysis that will be required. Stormwater effects are generally more pronounced in small receiving water bodies, and/or in water bodies that already exhibit signs of impairment. BAs must characterize the conditions that prevail in any water bodies (including wetlands) to which stormwater will be discharged.

Conditions within receiving waterbodies should be clearly described in the existing environmental conditions section. The NOAA Fisheries (NMFS) and USFWS matrices of Pathways and Indicators (NOAA 1996; USFWS 1998) provide useful frameworks for completing this task. NMFS no longer requires inclusion of its matrix within biological assessments that are submitted to them for consultation, but relevant components of their matrix have been provided below for reference (Tables 17-2 and 17-4). USFWS still requires inclusion of its matrix in biological assessments submitted for consultation (Tables 17-3 and 17-5). For projects with potential water quality impacts, existing conditions for temperature, sediment/turbidity, and chemical contamination/nutrients should be established. A summary of these criteria is provided in the tables below (Tables 17-2 and 17-3).

For projects with potential impacts to habitat (i.e., effects from BMP construction or alteration of flows) it is important to include information on the existing conditions of the habitat types or characteristics within the action area, including stream type and aquatic habitat features, descriptions of substrate conditions, flow conditions (seasonal or perennial), and riparian habitat. In addition, the biologist should describe the suitability of habitat within the action area for a given species and life stage. All of this information helps the biologist to gauge whether there is potential for listed species to be exposed to stormwater impacts, and if there is exposure, what possible responses can be anticipated. If critical habitat is addressed in the BA, describe the primary constituent elements that currently exist within the action area and their condition. This information helps the biologist gauge whether there is the potential for impacts to critical habitat.

Providing a thorough description of existing conditions in the BA will help better explain what changes might take place and better support the effects analysis and effect determinations.

A summary of information that should be included is provided in the list below:

1. Describe existing habitat conditions within the action area paying particular attention to those habitat features and receiving water characteristics that may be affected by the proposed project. For bull trout describe existing conditions as specified in the USFWS Matrices of Pathways and Indicators.

    - For those indicators that will be potentially affected by the proposed project, include a detailed description within the text of the BA (in addition to the USFWS Pathways and Indicators summary matrix or checklist [described in CHAPTER 9 – ENVIRONMENTAL BASELINE]).

    - For those projects addressing stormwater impacts to receiving water quality, be sure to address the water quality criteria summarized in Tables 17-2 and 17-3 below.

Table 17-2. Water quality indicators identified in the NOAA Fisheries matrix of pathways and indicators.

	Indicators [a]	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	Temperature	50–57ºF [b]	57-60º (spawning) 57-64º (migration &rearing) [c]	> 60º (spawning) > 64º (migration & rearing) [c]
	Sediment/turbidity	<12% fines (<0.85 mm) in gravel [d], turbidity low	12-17% (west-side), [d] 12-20% (east-side), [c] turbidity moderate	>17% (west-side), [d] >20% (east side) [c] fines at surface or depth in spawning habitat [c], turbidity high
	Chemical contamination and nutrients	Low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no Clean Water Act 303(d) designated reaches	Moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one Clean Water Act 303(d) designated reach. [e]	High levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one Clean Water Act 303(d) designated reach. [e]

[a] The ranges of criteria presented here are not absolute; they may be adjusted for unique watersheds.

[b] Bjornn, T.C. and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. American Fisheries Society Special Publication 19:83-138. Meehan, W.R., ed.

[c] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

[d] Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee. 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

[e] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

Table 17-3. Water quality indicators identified in the USFWS matrix of pathways and indicators.

Diagnostic or Pathway	Indicators	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Water Quality	Temperature	7-day average maximum temperature in a reach during these life history stages: [b, c] Incubation 2 – 5ºC Rearing 4 – 12ºC Spawning 4 – 9ºC Also, temperatures do not exceed 15ºC in areas used by adults during migration (no thermal barriers).	7-day average maximum temperature in a reach during the following life history stages: [b, c] Incubation <2ºC or 6ºC Rearing <4ºC or 13 - 15ºC Spawning <4ºC or 10ºC Also, temperatures in areas used by adults during migration sometimes exceeds 15ºC.	7-day average maximum temperature in a reach during the following life history stages: [b, c] Incubation <1ºC or >6ºC Rearing >15ºC Spawning <4ºC or > 10ºC also temperatures in areas used by adults during migration regularly exceed 15ºC (thermal barriers present).
	Sediment (in areas of spawning & incubation; address rearing areas under *substrate embeddedness*)	Similar to Chinook salmon, [b] for example: <12% fines (<0.85 mm) in gravel, [d] ≤20% surface fines ≤6 mm. [e, f]	Similar to Chinook salmon: [b] e.g., 12-17% fines (<0.85mm) in gravel, [d] e.g., 12-20% surface fines. [g]	Similar to Chinook salmon [b]: e.g., >17% fines (<0.85mm) in gravel;[d] e.g., >20% fines at surface or depth in spawning habitat. [g]
	Chemical contamination & nutrients	Low levels of chemical contamination from agricultural, industrial, and other sources; no excess nutrients; no Clean Water Act 303(d) designated reaches. [h]	Moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one Clean Water Act 303(d) designated reach. [h]	High levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one Clean Water Act 303(d) designated reach. [h]

[a] The values of criteria presented here are not absolute; they may be adjusted for local watersheds given supportive documentation.

[b] Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. USDA Forest Service, Intermountain Research Station, Boise, ID.

[c] Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. In W.C. Mackay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings. P8.

[d] Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

[e] Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitewell, and K.A. Duncan. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-322.

[f] Overton, C.K., S.P. Wollrab, B.C. Roberts, and M.A. Radko. 1997. R1/R4 (Northern/Intermountain regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-346.

[g] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

[h] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

Table 17-4. Channel condition and hydrology indicators identified in the NOAA Fisheries matrix of pathways and indicators.

	Indicators [a]	Properly Functioning	At Risk	Not Properly Functioning
Channel Condition & Dynamics:	Width/depth ratio	<10 [c,e]	10–12	>12
	Stream bank condition	>90% stable; i.e., on average, less than 10% of banks are actively eroding [c]	80–90% stable	<80% stable
	Floodplain connectivity	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly
Flow/Hydrology:	Change in peak/base flows	Watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	Some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	Pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in drainage network	Zero or minimum increases in drainage network density due to roads [i,j]	Moderate increases in drainage network density due to roads (e.g., 5%) [i,j]	Significant increases in drainage network density due to roads (e.g., 20-25%) [i,j]

[a] The ranges of criteria presented here are not absolute; they may be adjusted for unique watersheds.
[c] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.
[e] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.
[i] Wemple, B.C. 1994. Hydrologic Integration of Forest Roads with Stream Networks in Two Basins, Western Cascades, Oregon. M.S. Thesis, Geosciences Department, Oregon State University.
[j] e.g., see Elk River Watershed Analysis Report, 1995. Siskiyou National Forest, Oregon.

Table 17-5. Channel condition and hydrology indicators identified in the USFWS matrix of pathways and indicators.

Diagnostic or Pathway	Indicators [a]	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Channel Condition & Dynamics	Average wetted width/ maximum depth ratio in scour pools in a reach	≤10 [h, f]	11–20 [f]	>20 [f]
	Stream bank condition	>80% of any stream reach has ≥90% stability.[f]	50–80% of any stream reach has ≥90% stability [f]	<50% of any stream reach has ≥90% stability [f]
	Floodplain connectivity	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly
Flow/Hydrology	Change in peak & base flows	Watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology, and geography.	Some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	Pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in drainage network	Zero or minimum increases in active channel length correlated with human caused disturbance.	Low to moderate increase in active channel length correlated with human caused disturbance	Greater than moderate increase in active channel length correlated with human caused disturbance

[a] The values of criteria presented here are not absolute; they may be adjusted for local watersheds given supportive documentation.

[f] Overton, C.K., S.P. Wollrab, B.C. Roberts, and M.A. Radko. 1997. R1/R4 (Northern/Intermountain regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-346.

[h] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

- For those projects addressing stormwater impacts to flow, be sure to address the habitat and hydrology criteria summarized in the Tables 17-4 and 17-5 below.
- For those indicators that will not be affected by the project, provide a summary of their condition in the matrix with a brief textual summary, and include your more detailed write-up of the indicator in an appendix of the BA.

2. Describe the condition of the habitat relative to the species' habitat needs. Describe suitability for each species and lifestages that may occur within the action area. For example, is it suitable rearing or spawning habitat? Is the habitat FMO (foraging, migratory or overwintering habitat) for bull trout? By establishing clearly what habitat types are present within the action area and whether or not they are suitable for various life stages, the biologist can more clearly define the scope of their effects analysis for each species.

3. For critical habitat, evaluate the existing condition for each of the identified Primary Constituent Elements that occur within the project action area.

4. When/where a dilution modeling is required (see Section 17.2.6.1 for eastern Washington protocol and Section 17.2.6.2 for western Washington protocol), gather additional information on the receiving waterbodies' characteristics. The biologist may need to request support from the project hydrologist in gathering this information:

   - Channel geometry (e.g., stream depth, stream velocity, channel width, slope, or Mannings Roughness)
   - Water chemistry (e.g., hardness, representative background concentrations for each water quality parameter of interest. Currently the following stormwater pollutants are being analyzed: Total Suspended Solids, dissolved and total copper, dissolved and total zinc).
   - Water quality (i.e., temperature, other potential pollutants such as pesticides, dissolved oxygen, etc).

If there is no data available, you will not be able to document the existing conditions in the receiving body. In this case, it may be possible to find existing data for a comparable system. Check with the WSDOT Stormwater and Watersheds Program Manager before using data from a comparable system. In addition, WSDOT liaisons at NMFS and USFWS should be consulted to ensure there is mutual agreement regarding the surrogate system that is chosen for analysis.

When selecting data sources, strive to utilize data that has been quality controlled. Potential information sources include:

- MGSFlood Hydrologic Model for precipitation data
- Department of Ecology (DOE) 303(d) list
- Department of Ecology Environmental Information Management (EIM) system for water quality data: <http://apps.ecy.wa.gov/eimreporting/Search.asp>
- The Limiting Factors Analysis by Washington State Conservation Commission
- Local agencies
- USGS Annual Washington State Data Report for water year 2005: <http://wa.water.usgs.gov/data>
- Additional water quality information may be available from the Environmental Protection Agency and the United States Geological Survey.

The last section of this chapter provides a list of on-line resources that provide existing information on existing receiving water conditions including, water quality, flow, and if it is an exempt waterbody.

17.2.6 Step 6: Determine the Extent of Effects Associated with Stormwater and Stormwater BMPs

This section provides guidance for analyzing stormwater effects for eastern (Section 17.2.6.1) and western Washington (Section 17.2.6.2). The guidance provided for analyzing effects on flow and duration can be used both for the delineation of the action area, as well as for an assessment of direct and indirect project effects upon listed species and critical habitat. The protocols outlined for analyzing stormwater quality are more focused in that they provide guidance specifically for assessing direct and indirect project water quality effects upon listed species and critical habitat and not for describing the full geographic extent of project-related water quality effects.

Projects that will not have stormwater effects on listed species or proposed or designated critical habitat due to location, absence of the species and habitats, or a project type that does not have new impervious surface and does not alter flow conditions (e.g., bridge seismic retrofit, ACP overlay, guardrail installation, a project area that is located a great distance from surface water, a project that can infiltrate all runoff due to highly permeable soils, etc.) need not complete a detailed stormwater analysis. These projects are expected to include a brief stormwater discussion as part of the project description and to document project effects (or lack thereof) on listed species along with supporting rationale in the effects analysis section of the BA.

Stormwater BMPs reduce impacts resulting from the development of pollution-generating impervious surface. Although BMPs reduce the effects of impervious surface, they do not completely eliminate the effects to either flow (base, peak or duration) or water quality for many projects.

For those projects that could expose and potentially affect listed species or proposed or designated critical habitat, documentation and analysis is required. A BA's stormwater analysis consists of two parts:

1. An analysis of the effects of changes in flow
2. An analysis of the effects of changes in water quality

While the flow analysis protocols are similar for projects in eastern and western Washington, two distinct procedures have been developed for analyzing the water quality aspects of stormwater effects in eastern Washington and western Washington. In addition, supplemental guidance has been developed to address water quality impacts resulting from stormwater runoff associated with development identified as an indirect effect of transportation projects in western Washington (see Section 17.3). A step by step description of how to implement the two components of a BA stormwater analysis for eastern and western Washington is outlined in the subsections below.

17.2.6.1 Eastern Washington Stormwater Analytical Process

Analyzing Effects on Flow Conditions and Local Hydrology

Changes in flow conditions and local hydrology can result in direct and indirect effects to species and critical habitats including: Changes to channel characteristics (pool/riffle/run configuration; bank stability; etc.) due to scour, substrate impacts due to fines introduced via bank destabilization or scour depositional areas, introduction of excess fines and related effects to substrate conditions or the food base, direct effects to active redds, eggs, or emerging fry resulting from scour and/or deposition, indirect effects to temperature associated with reduced base flows.

To analyze potential effects on peak flow rates, the rational method or single event hydrograph methods (Soil Conservation Service [SCS] or Santa Barbara Unit Hydrograph [SBUH]) can be used. To provide a detailed quantitative analysis of potential project effects on flow durations, a continuous hydrologic simulation model would be needed but no such model is available for use in eastern Washington and therefore a surrogate analysis method using a single event hydrograph method should be employed. The *Highway Runoff Manual* provides flow control design guidance for eastern Washington for use with a unit hydrograph model that approximates the peak flow reduction needed to prevent an increase in the durations of channel-forming peak flows. This guidance can be used as a surrogate threshold to determine if proposed flow control measures are adequate to prevent this impact.

Occasionally, transportation projects are associated with indirect effects in the form of urban and suburban development or changes in land use. As a result, the biologist may also need to characterize, how these associated changes could affect flow patterns within these additional areas, and in turn how these changes would affect conditions within receiving water bodies.

This analysis should be completed by qualified WSDOT or consultant staff as determined by the WSDOT project manager. The project biologist will need to coordinate with the WSDOT project manager to ensure that they receive results from this analysis for inclusion in the biological assessment.

Once the project biologist has received the results of the analysis described above, they should work with the hydrologist or modeler to describe the following:

- What changes to flows are anticipated (base, peak)?
- How do anticipated flows compare to, and how will they affect existing conditions?
- How may changes in flow potentially affect habitat characteristics, and conditions in the project's receiving waterbodies?
- Will altered flows or local hydrology affect habitat for listed species (or habitat forming processes) in a manner that impairs function, reduces suitability, or otherwise disrupts normal behavior (feeding, moving, sheltering, etc.)?

The BA must evaluate the effects associated with the proposed flow control measures over time, including describing the expected performance standards (at and below the design storm event) and known limitations of the proposed flow control measures if storm events exceed or greatly exceed the design storm event. For stormwater runoff that runs through an infiltration BMP, water will only be discharged into receiving water when the rainfall event exceeds the capacity of the BMP. Some BMPs discharge at their designed discharge storm events.

A project will minimize its effects on flow if it can fully disperse or infiltrate all runoff from new impervious area, without discharging this runoff either directly or indirectly through a conveyance system to surface waters. Most of the projects occurring in eastern Washington are expected to use infiltration or dispersion for flow control. Very few projects will require a detailed flow analysis.

The NMFS and USFWS consider there will be no effect to flow of the receiving waters for projects discharging to the Columbia River. NMFS considers there will be no effect to flow only when water is not transferred from contributing watersheds with ESA or EFH resources.

Discharges to any HRM exempt waterbody (except the Columbia River) requires providing in the BA either the rationale as to why there is no effect on flow or a detailed description of anticipated project impacts to flow. Use the Exempt Surface Waters List (see Online Resources in Section 17.4) to determine if your water body is exempt from flow control requirements and the farthest upstream point and/or reach for the exemption (if applicable). A project may have discountable flow effects on listed species if the project discharges to an HRM exempt water body and the project engineers can provide sufficient rationale or documentation that the project will have insignificant effects on flow within a receiving water body.

If a project could measurably affect flow in a receiving water body, the biologist must evaluate whether the anticipated changes to habitat will have any effect on the suitability of habitat or the quality and/or functionality of any primary constituent elements of critical habitat. Factors to consider that may reduce habitat quality or functionality include:

- Changes to channel characteristics (pool/riffle/run configuration; bank stability; etc.) due to scour
- Substrate impacts due to fines introduced via bank destabilization or scour depositional areas
- Introduction of excess fines and related effects to substrate conditions or the food base
- Direct effects to active redds, eggs, or emerging fry resulting from scour and/or deposition
- Indirect effects to temperature associated with reduced base flows

The impacts to habitat resulting in direct or indirect effects to the listed species or critical habitat will influence the stormwater-related effect determination(s) for the project. The project biologist must also determine whether specific life-stages could be exposed to the effects generated by altered flows. If exposure could occur, determining the anticipated response of affected fish will also help to form the stormwater-related effect determination.

Analyzing Effects on Water Quality

Stormwater runoff from roads conveys pollutants, sometimes at concentrations that are toxic to fish (Spence et al. 1996). The main pollutants of concern are heavy metals from vehicle sources (EPA 1980). Additionally, Polycyclic Aromatic Hydrocarbons (PAHs) from urbanized areas (Van Metre et al. 2000; Kayhanian et al. 2003) can have long-term deleterious effects on salmonids (Peterson et al. 2003). Finally, roads can also deliver pesticides to surface waters (Kayhanian et al. 2003). The relative success of removing pollutants from stormwater runoff depends upon the treatment technology used, and maintenance of treatment facilities. Studies indicate variability among different treatment applications (Schueler 1987; Hayes et al. 1996; Young et al. 1996).

Stormwater-delivered pollutants can affect the physiological or behavioral performance of salmonids in ways that reduce growth, migratory success, reproduction, and cause death. Water quality degradation can contribute to a reduction of growth and immune system function that reduce growth and subsequent ocean survival. The likelihood and extent of effects on fish from the discharge of roadway pollutants to surface waters can vary spatially and temporally. Effects are influenced by background water quality conditions, life stage of the fish, duration of exposure, concentration and relative toxicity of the pollutants, and concurrent discharges and/or background levels of other contaminants.

Currently stormwater assessments in biological assessments focus upon total suspended solids and total and dissolved copper and zinc. The potential effects associated with each of these is summarized below.

Sediment

Sediment introduced into streams can degrade spawning and incubation habitat, and negatively affect primary and secondary productivity. This may disrupt feeding and territorial behavior through short-term exposure to turbid water. Research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd et al. 1987; Servizi and Martens 1991).

Quantifying turbidity levels and their effects on listed fish is complicated by several factors. First, turbidity from an activity will typically decrease as distance from the activity increases. How quickly turbidity levels attenuate within the water column is dependent upon the quantity of materials in suspension (e.g., mass or volume), the particle size of suspended sediments, the amount and velocity of receiving water (dilution factor), and the physical and chemical properties of the sediments. Second, the impact of turbidity on fish is not only related to the turbidity levels, but also the particle size of the suspended sediments. Also, the lifestage of the fish at exposure, and water temperature influence the effects that fish will experience.

Effects of suspended sediment, either as turbidity or suspended solids, on fish are well documented (Bash et al. 2001). Suspended sediments can affect fish behavior and physiology and result in stress and reduced survival. Temperature acts synergistically to increase the effect of suspended sediment. The severity of effect of suspended sediment increases as a function of the sediment concentration and exposure time, or dose (Newcombe and Jensen 1996; Bash et al. 2001). Suspended sediments can cause sublethal effects such as elevated blood sugars and cough rates (Servizi and Martens 1991), physiological stress, and reduced growth rates. Elevated turbidity levels can reduce the ability of salmonids to detect prey, cause gill damage (Sigler et al. 1984; Lloyd et al. 1987; Bash et al. 2001), and cause juvenile steelhead to leave rearing areas (Sigler et al. 1984). Additionally, studies indicate that short-term pulses of suspended sediment influence territorial, gill-flaring, and feeding behavior of salmon under laboratory conditions (Berg and Northcote 1985). Also, a potentially positive reported effect is providing refuge and cover from predation, though this circumstance is considered to be limited. Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991).

Fine sediment can also affect food for juvenile salmonids. Embedded gravel and cobble reduce access to microhabitats (Brusven and Prather 1974), entombing and suffocating benthic organisms. When fine sediment is deposited on gravel and cobble, benthic species diversity and densities have been documented to drop significantly (Cordone and Pennoyer 1960; Herbert et al. 1961; Bullard, Jr. 1965; Reed and Elliot 1972; Nuttall and Bilby 1973; Bjornn et al. 1974; Cederholm et al. 1978).

Metals

There are three known physiological pathways of metal exposure and uptake within salmonids: (1) gill surfaces can uptake metal ions which are then rapidly delivered to biological proteins (Niyogi et al. 2004); (2) olfaction (sense of smell) receptor neurons (Baldwin et al. 2003), and; (3) dietary uptake. Of these three pathways, the mechanism of dietary uptake of metals is least understood. For dissolved metals, the most direct pathway to aquatic organisms is through the gills (Kerwin and Nelson 2000).

Relative toxicity of metals can be altered by hardness, water temperature, pH, suspended solids, and presence of other metals. Water hardness affects the bio-available fraction of metals from gill surfaces; as hardness increases; metals are less bio-available, and therefore less toxic (Kerwin and Nelson 2000; Hansen et al. 2002b; Niyogi et al. 2004). However, Baldwin et al. (2003) did not find any influence of water hardness on the inhibiting effect of copper on salmon olfactory functions. Olfactory inhibition can decrease the ability of salmon to recognize and avoid predators and navigate back to natal streams for spawning, resulting in reduced spawning success, and increased predation (Baldwin et al. 2003).

The annual loadings of water quality contaminants from untreated or poorly treated road stormwater runoff can result in sublethal effects that occur sooner and/or more often relative to existing conditions. Exposure to metal mixtures may result in sublethal effects that reduce growth or immune system functions that could persist after Chinook leave their natal streams. Arkoosh et al. (1998) determined that alteration in disease resistance was sustained even after Chinook were removed from the source of pollutants for 2 months (and kept in hatcheries), and concluded that immune alteration in early life stages may persist into early ocean residency of Chinook.

Most published literature concerns the acute toxicity of most metals on an individual basis, though in aquatic receiving bodies most metals typically exist in mixtures, and are known to interact with each other (Niyogi et al. 2004). These mixtures interacting at gill (and olfaction) mediums likely result in adverse effects, and the physiological consequence of metal mixtures is a continuing area of study (Niyogi et al. 2004). However, individual metal concentrations, and some mixture concentrations and combinations have been tested with a variety of *Oncorhynchus* (i.e., Chinook, coho, and rainbow trout), and *Salvelinus* (bull and brook trout) species. Tested endpoints range from lethal to sublethal effects, which include reduced growth, fecundity, avoidance, reduced stamina, and neurophysiological and histological effects on the olfactory system. For example, mixtures containing copper and zinc were found to have greater than additive toxicity to a wide variety of aquatic organisms including freshwater fish (Eisler 1998), and other metal mixtures also yielded greater than additive toxic effects at low dissolved metal concentrations (Playle 2004).

The steps for completing a water quality analysis in eastern Washington are depicted in Figure 17.1 below.

In order to answer the first question, “Can the proposed stormwater system be designed to prevent surface water discharges?” the biologist must work with the project hydrologist and stormwater engineer to fully describe the treatment strategy and anticipated discharges from the proposed project.

The second question states, “Is the project so far from receiving water that runoff will effectively infiltrate before reaching it?” This may be the case in unlined channel conveyances that have adequate soils, surface area, and contact time to allow for complete infiltration before surface water discharge. Answering yes to this question will require a discussion of the following items in the BA for justification:

- Type of conveyance – Conveyance must be an unlined open channel or ditch, not a pipe or lined conveyance ditch. Describe the general configuration.
- Distance to receiving water – This will affect the contact time and the capacity of the channel base to infiltrate runoff.
- Other inputs – Does the unlined open channel or ditch collect and/or convey substantial flow from off-site areas?
- Infiltratability of soil – Soils at the unlined open channel or ditch must have relatively high infiltration rate (Hydrologic Type A or B). See Section 17.4 Online Resources for Stormwater for sources of existing soil information.
- Depth to groundwater – Seasonal high groundwater table must not meet the unlined open channel or ditch base or be shallow. As a guideline, separation between seasonal high groundwater and the unlined open channel flow line should be 5 feet or greater for acceptable infiltration (criteria for infiltration BMPs – see Section 5-4.2.1 of the *Highway Runoff Manual* for more information).

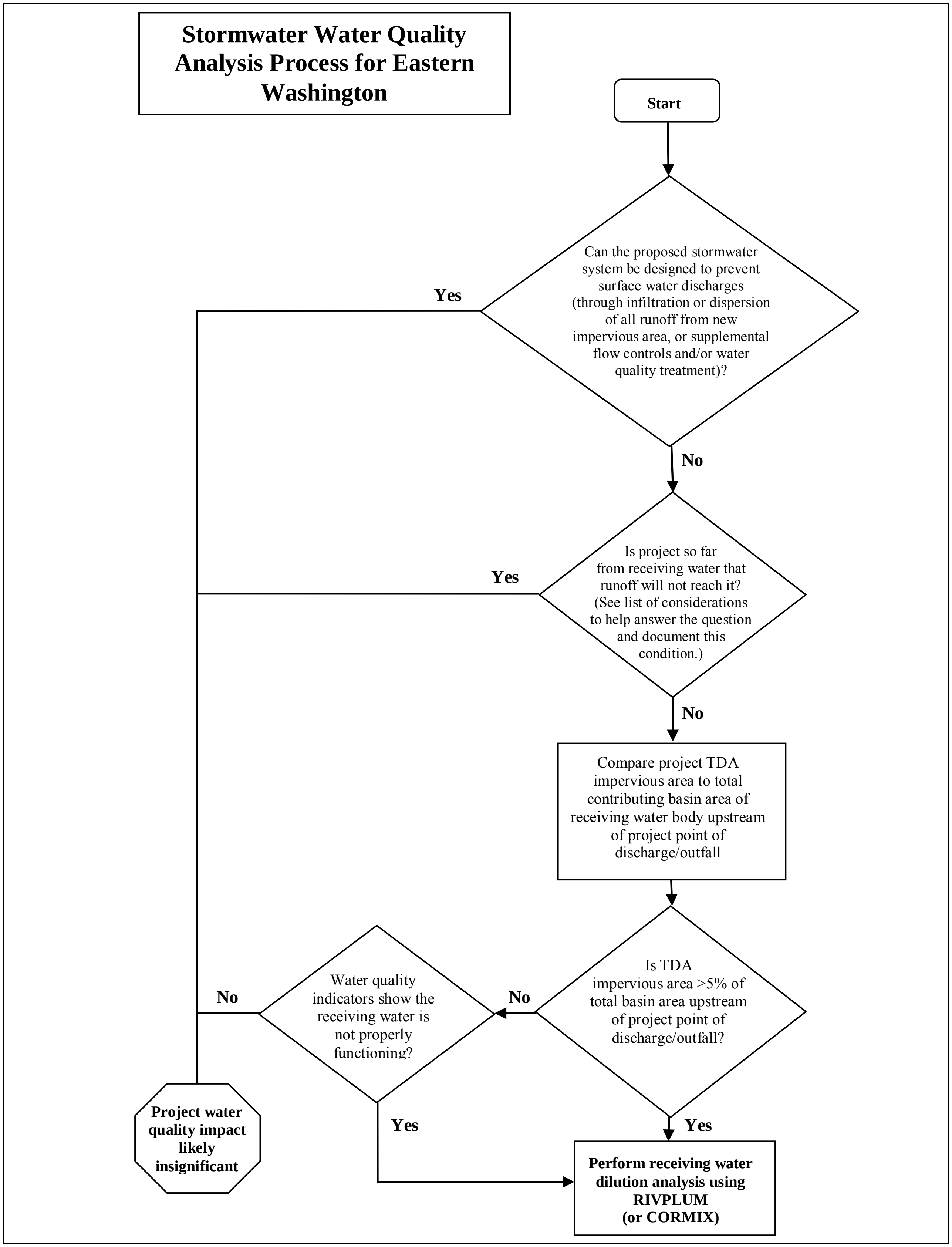

Figure 17.1. Stormwater water quality analysis process for Eastern Washington.

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- Observations of existing flow conditions – Document any observations of flow during a storm event or evidence of flow conditions in the unlined open channel or ditch during conditions that could potentially deliver stormwater to receiving waters (e.g., excessive snow melt during seasonally high groundwater period). If surface discharge of runoff to the receiving water is evident, answer "no" to the question.

The project biologist, hydrologist and stormwater engineer would need to work together to ensure this information was included in the BA.

The third question states, "Is TDA impervious area > 5% of the total basin area upstream of the project point of discharge/outfall?"

To perform the land-area based dilution analysis, the contributing impervious area for the project is compared to the total contributing basin area for the receiving water upstream of the project discharge. This analysis may be based on a TDA or project drainage basin approach depending on the length of the project, and the number and location of the receiving waterbodies. If the project drainage basin represents 5 percent or less of the total upstream basin area, it is assumed that the receiving water will have sufficient dilution capacity to mitigate potential impacts from the project **if** background water quality conditions are not degraded.

The following steps outline how the land-area based dilution analysis is completed:

1. Using the project's ESA stormwater checklist, determine the project's TDA impervious area or the projects total impervious area.

2. To determine if the TDA or project drainage basin is greater than 5 percent of the total basin area (contributing drainage area upstream of project discharge point in receiving water), the total basin area can be delineated using the on-line GIS-based tool StreamStats, developed by USGS: <http://water.usgs.gov/osw/streamstats/Washington.html>.

3. If the TDA or project drainage basin represents:

   - MORE than 5 percent of the receiving water drainage basin, then a receiving water dilution analysis using RIVPLUM for streams and rivers or CORMIX for lakes must be completed. Contact the Fish and Wildlife Program at WSDOT Headquarters for assistance in determining the annual load numbers for the calculations.

   - LESS than 5 percent of the receiving water drainage basin, then an analysis of the water quality conditions in the receiving waterbody must be completed. Water quality conditions in the receiving water are described by the water quality indicators in the NOAA Fisheries (NMFS) or USFWS Pathways and Indicators Matrices.

i. If the water quality indicators show the receiving water is *not properly functioning*, then a receiving water dilution analysis using RIVPLUM for streams and rivers or CORMIX for lakes must be completed.

ii. If the water quality indicators show the receiving water is *at risk* or *properly functioning*, then a water quality impacts are likely to be insignificant.

17.2.6.2 Western Washington Analytical Process

Analyzing Effects on Flow Conditions and Local Hydrology

Changes in flow conditions and local hydrology can result in direct and indirect effects to species and critical habitats including: Changes to channel characteristics (pool/riffle/run configuration; bank stability; etc.) due to scour, substrate impacts due to fines introduced via bank destabilization or scour depositional areas, introduction of excess fines and related effects to substrate conditions or the food base, direct effects to active redds, eggs, or emerging fry resulting from scour and/or deposition, indirect effects to temperature associated with reduced base flows.

To analyze potential project effects on flow and duration, a continuous simulation model can be used. MGSFlood is the primary continuous simulation model for use with WSDOT projects in western Washington, and is used to design flow control and runoff treatment BMPs. Other continuous simulation models that can be used to analyze flow and durations include the Western Washington Hydrology Model (WWHM) and King County Runoff Time Series (KCRTS).

This analysis should be completed by qualified WSDOT or consultant staff as determined by the WSDOT project manager. The project biologist will need to coordinate with the WSDOT project manager to ensure that they receive results from this analysis for inclusion in the biological assessment.

Occasionally, transportation projects are associated with indirect effects in the form of urban and suburban development or changes in land use. As a result, the biologist may also need to characterize, more generally or qualitatively, how these associated changes could affect flow patterns within these additional areas, and in turn how these changes would affect conditions within receiving water bodies. Guidance for addressing changes in flow patterns or hydrology for indirect effects has not been developed by the PMT due to the site-specific and project-specific considerations that would influence the assessment approach for characterizing these impacts. Analysis of hydrologic changes stemming from indirect effects requires coordination with WSDOT on a project by project basis.

Once the project biologist has received the results of the analysis described above, they should work with the hydrologist or modeler to describe the following:

- What changes to flows are anticipated (base, peak, duration)?
- How do anticipated flows compare to, and how will they affect existing conditions?
- How may changes in flow potentially affect habitat characteristics, and conditions in the project's receiving waterbodies?
- Will altered flows or local hydrology affect habitat for listed species (or habitat forming processes) in a manner that impairs function, reduces suitability, or otherwise disrupts normal behavior (feeding, moving, sheltering, etc.)?
- Will altered flows or local hydrology affect habitat conditions in a way that measurably affects the suitability and function of habitat for the listed species?

The BA must evaluate the effects associated with the proposed flow control measures over time, including describing the expected performance standards (at and below the design storm event) and known limitations of the proposed flow control measures if storm events exceed or greatly exceed the design storm event. For stormwater runoff that runs through an infiltration BMP, water will only be discharged into receiving water when the rainfall event exceeds the capacity of the BMP. Some BMPs discharge at their designed discharge storm events.

A project will minimize its effects on flow if it can fully disperse or infiltrate all runoff from new impervious area, without discharging this runoff either directly or indirectly through a conveyance system to surface waters.

The USFWS consider there will be no effect to flow of the receiving waters, for projects discharging to the following western Washington waterbodies: Puget Sound; Columbia River; and Lakes Sammamish, Silver, Union, Washington, and Whatcom. NMFS considers there will be no effect to flow of the receiving waters for projects discharging to the following western Washington waterbodies: Puget Sound, Columbia River, and Lake Washington, and only when water is not transferred from contributing watersheds with ESA or EFH resources. Discharges to any HRM exempt waterbody not on the USFWS and/or NMFS list requires providing in the BA either the rationale as to why there is no effect on flow or a detailed description of anticipated project impacts to flow. Use the Exempt Surface Waters List (see ONLINE RESOURCES in Section 17.4) to determine if your water body is exempt and the farthest upstream point and/or reach for the exemption (if applicable).

The biologist must evaluate whether the anticipated changes to habitat will have any effect on the suitability of habitat or the quality and/or functionality of any primary constituent elements of critical habitat. Factors to consider that may reduce habitat quality or functionality include:

- Changes to channel characteristics (pool/riffle/run configuration; bank stability; etc.) due to scour
- Substrate impacts due to fines introduced via bank destabilization or scour depositional areas
- Introduction of excess fines and related effects to substrate conditions or the food base
- Direct effects to active redds, eggs, or emerging fry resulting from scour and/or deposition
- Indirect effects to temperature associated with reduced base flows

The impacts to habitat resulting in direct or indirect effects to the listed species or critical habitat will also influence the stormwater-related effect determination(s) for the project. The project biologist must also determine whether specific life-stages could be exposed to the effects generated by altered flows. If exposure could occur, determining the anticipated response of affected fish will also help to inform the stormwater-related effect determination.

Analyzing Effects on Water Quality

Stormwater runoff from roads conveys pollutants, sometimes at concentrations that are toxic to fish (Spence et al. 1996). The main pollutants of concern are heavy metals from vehicle sources (EPA 1980). Additionally PAHs from urbanized areas (Van Metre et al. 2000; Kayhanian et al. 2003) can have long-term deleterious effects on salmonids (Peterson et al. 2003). Finally, roads can also deliver pesticides to surface waters (Kayhanian et al. 2003). The relative success of removing pollutants from stormwater runoff depends upon the treatment technology used, and maintenance of treatment facilities. Studies indicate variability among different treatment applications (Schueler 1987; Hayes et al. 1996; Young et al. 1996).

Stormwater-delivered pollutants can affect the physiological or behavioral performance of salmonids in ways that reduce growth, migratory success, reproduction, and cause death. Water-quality degradation can contribute to a reduction of growth and immune system function that reduce growth and subsequent ocean survival. The likelihood and extent of effects on fish from the discharge of roadway pollutants to surface waters can vary spatially and temporally. Effects are influenced by background water quality conditions, life stage of the fish, duration of exposure, concentration and relative toxicity of the pollutants, and concurrent discharges and/or background levels of other contaminants.

Currently, stormwater assessments in biological assessments focus on total suspended solids and total and dissolved copper and zinc. The potential effects associated with these pollutants are summarized below.

Sediment

Sediment introduced into streams can degrade spawning and incubation habitat, and negatively affect primary and secondary productivity. This may disrupt feeding and territorial behavior through short-term exposure to turbid water. Research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd et al. 1987; Servizi and Martens 1991).

Quantifying turbidity levels and their effects on listed fish is complicated by several factors. First, turbidity from an activity will typically decrease as distance from the activity increases. How quickly turbidity levels attenuate within the water column is dependent upon the quantity of materials in suspension (e.g., mass or volume), the particle size of suspended sediments, the amount and velocity of ambient water (dilution factor), and the physical and chemical properties of the sediments. Second, the impact of turbidity on fish is not only related to the turbidity levels, but also the particle size of the suspended sediments. Also, the lifestage of the fish at exposure, and water temperature influence the effects that fish will experience.

Effects of suspended sediment, either as turbidity or suspended solids, on fish are well documented (Bash et al. 2001). Suspended sediments can affect fish behavior and physiology and result in stress and reduced survival. Temperature acts synergistically to increase the effect of suspended sediment. The severity of effect of suspended sediment increases as a function of the sediment concentration and exposure time, or dose (Newcombe and Jensen 1996; Bash et al. 2001). Suspended sediments can cause sublethal effects such as elevated blood sugars and cough rates (Servizi and Martens 1991), physiological stress, and reduced growth rates. Elevated turbidity levels can reduce the ability of salmonids to detect prey, cause gill damage (Sigler et al. 1984; Lloyd et al. 1987; Bash et al. 2001), and cause juvenile steelhead to leave rearing areas (Sigler et al. 1984). Additionally, studies indicate that short-term pulses of suspended sediment influence territorial, gill-flaring, and feeding behavior of salmon under laboratory conditions (Berg and Northcote 1985). Also, a potentially positive reported effect is providing refuge and cover from predation, though this circumstance is considered to be limited. Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991).

Fine sediment can also affect food for juvenile salmonids. Embedded gravel and cobble reduce access to microhabitats (Brusven and Prather 1974), entombing and suffocating benthic organisms. When fine sediment is deposited on gravel and cobble, benthic species diversity and densities have been documented to drop significantly (Cordone and Pennoyer 1960; Herbert et al. 1961; Bullard, Jr. 1965; Reed and Elliot 1972; Nuttall and Bilby 1973; Bjornn et al. 1974; Cederholm et al. 1978).

Metals

There are three known physiological pathways of metal exposure and uptake within salmonids: (1) gill surfaces can uptake metal ions which are then rapidly delivered to biological proteins (Niyogi et al. 2004); (2) olfaction (sense of smell) receptor neurons (Baldwin et al. 2003); and (3) dietary uptake. Of these three pathways, the mechanism of dietary uptake of metals is least understood. For dissolved metals, the most direct pathway to aquatic organisms is through the gills (Kerwin and Nelson 2000).

Relative toxicity of metals can be altered by hardness, water temperature, pH, suspended solids, and presence of other metals. Water hardness affects the bio-available fraction of metals from gill surfaces; as hardness increases; metals are less bio-available, and therefore less toxic (Kerwin and Nelson 2000; Hansen et al. 2002b; Niyogi et al. 2004). However, Baldwin et al. (2003) did not find any influence of water hardness on the inhibiting effect of copper on salmon olfactory functions. Olfactory inhibition can decrease the ability of salmon to recognize and avoid predators and navigate back to natal streams for spawning, resulting in reduced spawning success, and increased predation (Baldwin et al. 2003).

Exposure to metal mixtures may result in sublethal effects that reduce growth or immune system functions that could persist after fish leave their natal streams. Arkoosh et al. (1998) determined that alteration in disease resistance was sustained even after Chinook were removed from the source of pollutants for 2 months (and kept in hatcheries), and concluded that immune alteration in early life stages may persist into early ocean residency of Chinook.

Most published literature concerns the acute toxicity of most metals on an individual basis, though in aquatic receiving bodies most metals typically exist in mixtures, and are known to interact with each other (Niyogi et al. 2004). These mixtures interacting at gill (and olfaction) mediums likely result in adverse effects, and the physiological consequence of metal mixtures is a continuing area of study (Niyogi et al. 2004). However, individual metal concentrations, and some mixture concentrations and combinations have been tested with a variety of *Oncorhynchus* (i.e., Chinook, coho, and rainbow trout), and *Salvelinus* (bull and brook trout) species. Tested endpoints range from lethal to sublethal effects, which include reduced growth, fecundity, avoidance, reduced stamina and neurophysiological and histological effects on the olfactory system. For example, mixtures containing copper and zinc were found to have greater than additive toxicity to a wide variety of aquatic organisms including freshwater fish (Eisler 1998), and other metal mixtures also yielded greater than additive toxic effects at low dissolved metal concentrations (Playle 2004).

In western Washington, a model has been developed for analyzing project-specific water quality impacts; the *Highway Runoff Dilution and Loading Model* (HI-RUN). The HI-RUN model provides a risk-based tool for evaluating exposure and potential effects on listed species. All BAs must include a rationale explaining if and how this analytical tool has been used, and a reference to the version/date of the model used in preparation of the BA. HI-RUN model can be used to conduct two primary analyses using separate subroutines:

1. End-of-pipe loading subroutine – Evaluation of existing and proposed pollutant loading values from a specific TDA, or the entire project area. Evaluation of existing and proposed pollutant concentrations at specific outfall discharge locations is also provided as output from this routine.

2. Receiving water dilution subroutine – Relative to the effects threshold, evaluation of existing and proposed pollutant concentrations at specific outfall discharge locations after mixing within the associated receiving water.

The procedure for analyzing potential water quality effects (western Washington) requires an examination of the anticipated dissolved zinc loadings at end-of-pipe. As mentioned in the existing environmental conditions section above, the existing environmental conditions (i.e., conditions within the receiving waterbody) may influence what analytical steps and model outputs are required for a given project. If existing conditions in the action area are "properly functioning" or "functioning at acceptable levels of risk" and if the end-of-pipe loading subroutine indicates the project will likely decrease annual pollutant loadings, it <u>may be unnecessary to run or provide outputs from the HI-RUN dilution subroutine</u>.

The HI-RUN Users Guide provides detailed step-by-step guidance to this procedure, but a brief summary is included here so that biologists can use this distilled guidance to begin their stormwater analysis and refer to the Users Guide only if additional information or clarification is needed.

Occasionally, transportation projects are associated with indirect effects in the form of urban and suburban development or changes in land use. The HI-RUN model only addresses water quality impacts resulting from highway runoff and cannot be used to address water quality impacts stemming from these other land cover types and impervious surfaces. For this reason, a separate procedure, summarized in Section 17.3, has been developed to characterize potential water quality effects resulting from these changes and is available on the WSDOT website. The method for analyzing water quality changes stemming from development that is indirectly related to a transportation project is intended to provide a coarse scale analysis of the changes in annual load for three stormwater pollutants from changes in land use and or impervious surface. This method uses a simple "wash-off" model that relies upon unit area annual pollutant loads (pounds/acre/year) for individual land uses to predict annual pollutant yields (pounds/year) from the changes in land use associated with the indirect effects of the project for the existing and projected conditions following completion of the transportation project. It is only applicable to projects in Western Washington and is only capable of predicting changes in pollutant loading, not changes in concentration or potential dilution zones.

The first step in using HI-RUN to evaluate water quality effects is to run the end-of-pipe loading subroutine to assess the potential of the proposed project to increase the delivery of pollutant loads to the receiving water when compared to the existing condition. The HI-RUN end-of-pipe loading subroutine can estimate loadings of five pollutants (total suspended solids, total copper, dissolved copper, total zinc, and dissolved zinc), and all five should be analyzed and reported in the BA. Model outputs from this subroutine provide estimates of pollutant loadings and a set of probabilities that may be used to assess whether the project is likely to increase or decrease annual pollutant loadings in each TDA (or receiving waterbody). The end-of-pipe subroutine should be run for the following:

- Run the end-of-pipe subroutine for each individual project TDA.
- If multiple TDAs discharge to the same receiving waterbody, the end-of-pipe subroutine can be run for the aggregate (combined) area of those TDAs to get a summary of overall loading to the system. However, results from this analysis should not be used as the basis for an analysis using the receiving water dilution subroutine. The dilution analysis is run for individual outfalls only.
    - For example, if three TDAs in a single project discharge to Hylebos Creek, calculating aggregate loading from all three TDAs to Hylebos Creek will help summarize total impacts to the fish populations utilizing that system.

To analyze multiple TDAs in aggregate, conduct an additional end-of-pipe loading analysis model run where:

- All the baseline area information from each individual TDA is added to together and entered into the corresponding rows in the model input page, and
- All the proposed area information from each individual TDA is added together and entered into the corresponding rows in the model input page.
    - As a hypothetical example, the three Hylebos Creek TDAs mentioned above have 2.5 acres, 1.3 acres, and 0 acres respectively of impervious area in the baseline condition that receive basic treatment with no incidental infiltration. To analyze aggregate loading to Hylebos Creek, conduct a new model run where 3.8 acres would be entered in the “Subbasin 1” cell of the input spreadsheet, corresponding to this treatment/infiltration combination. This combination of values would be repeated for each row (i.e., applicable treatment type and incidental infiltration category) for the baseline and proposed conditions tables.

If requested during consultation, or if it is considered useful by the project or Services biologist, the model can also be run for all project TDAs to summarize the overall loading associated with the project. The results from this analysis should not be used as the basis for a receiving water dilution analysis, but should simply provide a “big picture” summary of project related loading.

Once this step has been completed, the biologist follows the process outlined in Figure 17-2 below to determine whether the HI-RUN dilution subroutine is required. Once the outputs from the HI-RUN end-of-pipe loading subroutine are available, the biologist completes the following steps:

- The biologist reviews the results of the TDA-specific end-of-pipe loading subroutine (comparison of dissolved zinc [DZn], in particular the probability statistics [P(exceed)] for loading, to thresholds displayed in Figure 17-1) to determine the need for a detailed mixing zone analysis in the receiving water (HI-RUN receiving water dilution subroutine).
  - If the P(exceed) value for loading in a single TDA is greater than the 0.45 threshold, outputs from the HI-RUN receiving water dilution subroutine are required for the outfalls in that TDA.
  - If the P(exceed) value obtained from the end-of-pipe loading subroutine for DZn in the TDA is less than or equal to the 0.45 threshold value identified above, a second P(exceed) threshold value of 0.35 is examined.
  - If the P(exceed) value for loading in the TDA is greater than the 0.35 threshold, an alternate, less rigorous "land-area based" dilution analysis must be performed.
    - To perform the land-area based dilution analysis, the contributing impervious area for a TDA or the project drainage basin is compared to the total contributing basin area for the receiving water upstream of the project discharge.
      - If the TDA or project drainage basin represents 5 percent or less of the total upstream basin area, it is assumed that the receiving water will have sufficient dilution capacity to mitigate potential impacts from the project **if** background water quality conditions are not degraded. To determine if the project drainage basin is greater than 5 percent of the total basin area (contributing drainage area upstream of project discharge point in receiving water), the total basin area can be delineated using the on-line GIS-based tool StreamStats, developed by USGS: <http://water.usgs.gov/osw/streamstats/index.html>. It is important when using StreamStats to review the delineated drainage basin and confirm that it is accurate.

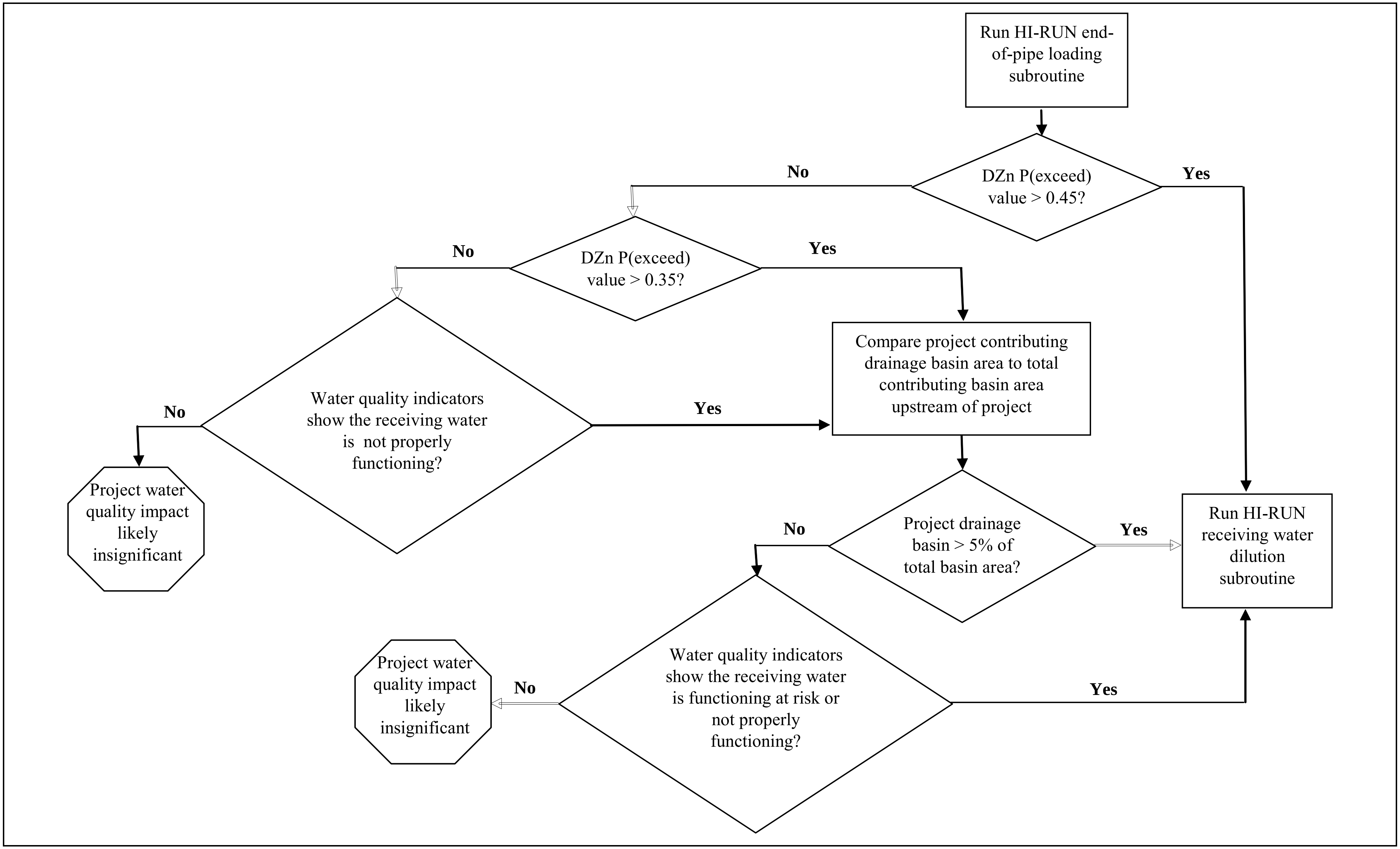


Figure 17-2. HI-RUN model stormwater analysis decision tree: Western Washington.

- Analyses using the receiving water dilution subroutine would still be required if the water quality indicators show the receiving water is functioning *at risk* or *not properly functioning*. Water quality conditions in the receiving water are described by the water quality indicators in the NOAA Fisheries (NMFS) or USFWS Pathways and Indicators Matrices.

□ If the P(exceed) value for loading is less than or equal to the 0.35 threshold, the background water quality conditions of the receiving waterbody must be examined.

– If the water quality criteria are *not properly functioning*, then the alternate, "land-area based" dilution analysis must be performed as described above.

– If the water quality criteria are *at risk* or *properly functioning*, then the project-related water quality impacts are likely insignificant and the biologist would need to document why this is the case (see Step 4 above for how to document).

The annual loadings of water quality contaminants from untreated or treated road stormwater runoff can result in sublethal effects to fish. Projects that can demonstrate that they will reliably achieve a reduction of pollutant loadings (for all pollutants of interest and in all or most TDAs) should use this information in a discussion in the BA on the general adequacy of the proposed stormwater design. For projects that cannot demonstrate that they will reliably achieve a reduction of pollutant loadings (for all pollutants of interest and in all or most TDAs), additional steps must be taken to assess exposure and potential effects to listed species and their habitat.

If HI-RUN receiving water dilution subroutine modeling predicts exposure above the established biological thresholds for zinc and copper could occur, or that there is an increase in the area of potential exposure when comparing baseline versus proposed conditions, the biologist must then evaluate whether site-specific conditions could potentially mitigate or reduce these estimated impacts (i.e., does runoff flow directly to treatment BMPs or is there flow over vegetated or permeable surfaces prior to reaching the BMP, are there unlined conveyance elements or ditches that could result in additional infiltration, etc.). This may be a qualitative or quantitative analysis that accompanies modeling results. Factors to consider in this analysis are summarized in Step 7 below.

In order to assess impacts to species and critical habitat, the project biologist should work with the project engineer or water quality modeler to describe the following:

- When project related changes to water quality are anticipated

- How anticipated changes to water quality compare to and affect existing conditions
- How changes to water quality will potentially affect habitat suitability and species

The project biologist must determine whether listed species (individuals) and specific life-stages are potentially present (temporally or spatially) and could be exposed to the water quality effects of the proposed project. If exposure could occur, determining the geographic extent and timing of this exposure will help the biologist determine the anticipated response of affected fish. The biologist must also evaluate whether the anticipated changes to water quality will have any short- or long-term effect on the suitability of habitat or the quality or functioning of any primary constituent elements.

Two case studies are presented below, based upon the case studies contained in the HI-RUN Users Guide, to demonstrate use of the HI-RUN model in the stormwater quality effects analysis process and how to interpret model results for analyzing stormwater effects on species and critical habitat. Case Study #1 involves using the end-of-pipe loading subroutine, but not the receiving water dilution subroutine. Case Study #2 involves the use of both routines. The case studies below differ from what is presented in the User's Guide in that they provide additional detail regarding how model outputs are interpreted.

Case Study #1. Completing the End-of-Pipe Loading Subroutine

The hypothetical project evaluated in Case Study #1 has the following characteristics:

- Existing roadway area: 10 acres
- Existing treatment: none
- Proposed roadway area: 12 acres (2 additional acres)
- Proposed treatment: biofiltration swale (sized for 2 acres) and media filter drain (previously referred to as ecology embankments) sized for 4 additional acres (retrofit)
- Outfall: All runoff in the TDA discharges through a single outfall (only one subbasin)
- Incidental infiltration: Due to sufficient separation between the base of the media filter drain and the seasonal high water table elevation, it is determined that the facility will achieve approximately 60 percent infiltration on an annual runoff volume basis. The biofiltration swale is not expected to have substantial incidental infiltration. The project biologist should work with the project engineer or designer to determine the anticipated infiltration rates and hydrologic performance of media filter

drains (previously called ecology embankments) and compost-amended vegetated filter strips if these BMPs are components of a project's design. The performance of these BMPs will vary based upon site-specific designs and conditions.

- Detention: Detention is not planned for this TDA because the receiving water is exempt from flow control requirements.

ESA-listed fish species present in the project receiving water include Puget Sound Chinook salmon and Puget Sound steelhead. The example focuses on evaluating the potential water quality effects of highway runoff on rearing steelhead in the month of February. However, the determination of which months to run the model for must be based on the potential presence of both steelhead and Chinook in the action area. If they are expected to be present year round, then the model should be run for all 12 months. If the action area is rearing habitat for both species, and they are not expected to be present during July, August, and September due to low or no flow conditions and temperature, then the model would only need to be run for the other 9 months. Complete documentation for why only 9 months was analyzed must be included in the document.

The model inputs for Case Study #1 are described in detail in the HI-RUN Users Guide, and the resulting output for the End-of-Pipe Loading Subroutine for Case Study #1 appears in Figure 17-3 below.

The P(exceed) value for dissolved zinc loading is used to determine what level of analysis (if any) is needed of water quality effects in the receiving water. Based upon the thresholds for dissolved zinc described in the flow chart (Figure 17-2), the resulting P(exceed) value (0.438) is less than the upper threshold value of 0.45, but greater than the lower threshold value of 0.35. Therefore, a simplified dilution analysis must be conducted as a next step.

The model output should be provided in an appendix to the BA. But the results from the model output should be summarized within the BA. For a biologist, the P(exceed) values for all of the pollutants evaluated can be used in the BA to describe the general effect of the project on annual loads relative to existing conditions. In this case, the loads for dissolved zinc occurring post project are higher than existing loads 44 percent of the time and lower than existing conditions 56 percent of the time, indicating there is a slight improvement in water quality conditions resulting from the proposed project on dissolved zinc. The loads for dissolved copper occurring post project are higher than existing loads 46 percent of the time and lower than existing conditions 54 percent of the time, indicating there is a slight improvement in water quality conditions resulting from the proposed project. The results for the annual load analysis for all five pollutants of concern (TSS, total and dissolved copper and zinc) should be included in a summary table in the BA. Table 17-6 provides a generalized format summarizing these data. Note this table presents purely hypothetical data and does not directly incorporate results from Case Study #1. The actual model output/report should be placed in an appendix.

Highway Runoff Dilution and Loading model (HI-RUN) Version 2.0

End of Pipe Loading Subroutine Report

This model is for stormwater analysis associated with biological assessments, and is not a design tool.

Input Summary

Run Date/Time: 12/30/10 13:56
Outfall ID: SR 13, MP 12.2, TDA 3
Rain Gauge: Puget East 40
Description: Case Study #1 - 11/29/10

← Location Information

Discharge Areas

Subbasin 1 - Baseline Conditions - 10 acres
no treatment - 0% infiltration - 10 acres

← Baseline Conditions

Subbasin 1 - Proposed Conditions - 12 acres
basic treatment - 0% infiltration - 2 acres
enhanced treatment - 60% infiltration - 4 acres
no treatment - 0% infiltration - 6 acres

← Location Information

Load Analysis

	Dissolved Copper Load (lb/yr)		Dissolved Zinc Load (lb/yr)	
	Baseline	Proposed	Baseline	Proposed
Max	8.75	5.6	126	30
75th Percentile	0.464	0.36	3.77	2.7
Median	0.268	0.24	2	1.6
25th Percentile	0.154	0.16	1.05	1
Min	0.005	0.031	0.033	0.18
P (exceed)		0.463		0.438

Annual Loading Statistics

P to Exceed → P (exceed)

P to Exceed Copper

P to Exceed Zinc

Concentration Analysis

Subbasin 1	Dissolved Copper Conc (mg/L)		Dissolved Zinc Conc (mg/L)	
	Baseline	Proposed	Baseline	Proposed
Max	0.061	0.062	0.929	0.74
75th Percentile	0.006	0.005	0.05	0.039
Median	0.004	0.004	0.027	0.024
25th Percentile	0.002	0.003	0.014	0.016
Min	0	0.001	0.001	0.004
P (exceed)		0.51		0.476

End of Pipe Concentration Statistics

Figure 17-3. End-of-pipe loading subroutine results – Case Study #1.

Table 17-6. Example table format for summarizing results from annual pollutant load analysis from the HI-RUN end-of-pipe subroutine.

Parameter	Median Existing Load (lbs/year)	Median Proposed Load (lbs/year)	P(exceed) Value
TSS	4,513	2927	0.39
TCu	1.16	0.81	0.38
DCu	0.268	0.230	0.46
TZn	7.03	4.80	0.38
DZn	1.99	1.60	0.44

The results provided in the highlighted column indicate the following:

- 39 percent of the time, total suspended solids associated with the proposed condition exceed the existing condition (end-of-pipe). This indicates the proposed project will generally result in improved conditions.

- 38 percent of the time, total copper levels associated with the proposed condition exceed the existing condition (end-of-pipe). This indicates the proposed project will generally result in improved conditions.

- 46 percent of the time, dissolved copper levels associated with the proposed condition exceed the existing condition (end-of-pipe). This indicates the proposed project may result in improved conditions. Completing a dilution analysis, if this analytical step is triggered by the P(exceed) values for dissolved zinc exceeding HI-RUN thresholds, would help to determine the extent of potential improvements.

- 38 percent of the time, total zinc levels associated with the proposed condition exceed the existing condition (end-of-pipe). This indicates the proposed project will generally result in improved conditions.

- 44 percent of the time, dissolved zinc levels associated with the proposed condition exceed the existing condition (end-of-pipe). Note that the resulting P(exceed) value (0.44) is less than the upper threshold value of 0.45, but greater than the lower threshold value of 0.35. Therefore, a simplified dilution analysis must be conducted as a next step.

In addition, the biologist might use the other summary statistics provided to describe the effect of the proposed project on existing conditions. The maximum values provide a worst-case load estimate for comparing the existing and proposed conditions. Similarly, the median values provide the most likely load estimate for comparing the proposed and existing conditions. The percentile values provide an indication of the overall distribution of the loading estimates. For example, the 75th percentile value represents the load estimate at which 75 percent of the values will be lower and 25 percent will be higher. These statistics can help the biologist describe the relative risk associated with impacts resulting from the proposed project. In this case study, the proposed project will reduce the load of both dissolved copper and dissolved zinc in all cases except the 25th percentile for dissolved copper and the minimum for both dissolved copper and dissolved zinc indicating that there is a very low risk that the project will increase annual loads for both dissolved copper and zinc.

In addition, the end of pipe loading routine provides end-of-pipe concentrations summary statistics and concentrations for various durations of storm/discharge. The end-of-pipe concentrations do not accurately reflect the conditions fish would be exposed to within the receiving waterbody. As a result, concentration output from the end-of-pipe loading subroutine should be used to describe the quality of stormwater discharged to the receiving waterbody not to support any detailed discussions regarding effects of stormwater to species or habitat within the receiving waterbody itself.

Case Study #1 then completes a simplified dilution analysis that indicates that the impervious surface area within this project TDA is less than 5 percent of the receiving water drainage basin. To complete this analysis, complete the following steps:

- Estimate the area (in square miles or acres) of the receiving water drainage basin upstream of the project discharge point.
    - Receiving water drainage basin area can be estimated using StreamStats, an online tool developed by USGS (<http://water.usgs.gov/osw/streamstats/Washington.html>).
    - Other topographic mapping could also be used to determine this area.
- The simplified dilution analysis consists of a simple comparison of the project drainage area (TDA) to this greater receiving water drainage basin.
    - If the impervious area of the TDA being analyzed represents more than 5 percent of the receiving water drainage basin, then the receiving water dilution subroutine must be conducted (see Case Study #2 for step-by-step instructions).
    - If not, a final check of receiving water indicators must be conducted.

This outcome requires the project biologist to revisit the water quality criteria to determine if the water quality indicators are functioning at risk or not properly functioning (see Figure 17-2). In this case, the receiving water existing conditions are properly functioning, and there is no additional stormwater dilution modeling required.

The biologist should summarize and discuss the results of the stormwater analysis in the "Analysis of Effects" section as follows:

- Describe project-generated differences in the pre- and post-project loading; compare loading estimates (Table 17-6 provides a generalized format for presenting these results).

- Describe the location of the outfall(s)/ point(s) of discharge with reference to habitat suitability, species occurrence, and potential for exposure.

- Report the results of the simplified dilution analysis by including the results of the watershed analysis. Include information like the size of the watershed in relation to the size of the TDA, and any information about the watershed (e.g., the amount of impervious surface) that may be available and relevant to discussion of water quality in the watershed. Include a discussion of the water quality existing indicators. Stormwater effects are generally more pronounced in small receiving waterbodies and/or in watersheds that already exhibit signs of impairment.

- Discuss the potential for exposure of listed fish to stormwater discharge. Include information on the lifestage that may be exposed. If there is a potential for exposure, include a general discussion on potential responses (of species or lifestage) to increased or decreased pollutant loads.

In general, changes in loading affect baseline conditions in the receiving water body, which in turn may affect the suitability of habitat for listed species. Increased pollutant loads contribute to the continued or increased degradation of baseline water quality conditions. Though changes in loading may contribute to sublethal effects to listed aquatic species via ingestion or food chain interactions, these changes can rarely be linked directly to injury of listed aquatic species.

The fate of stormwater constituents in the receiving water will vary based on their chemistry and the chemistry of the receiving water. Some chemicals may bind tightly to sediment and eventually settle into the substrate. Only fish species and habitat components that are closely associated with the substrate during periods of stability or those that are present during events that resuspend sediments are likely to be exposed through absorption or ingestion. Depending on the environmental and biological fate of the stormwater constituent, exposure to other species may occur through food web interactions.

Some stormwater constituents may remain in the water column and be more available to species that use the site. Depending on the species length of time at the site and their life stage, they may be exposed through absorption and ingestion. Again, depending on the environmental and biological fate of the chemical of concern, exposure to other species may occur through food web interactions. Though the HI-RUN model does not include cadmium, lead, chromium and PAHs, these are other pollutants that can potentially affect fish. Lead levels in stormwater runoff have declined to extremely low levels following the removal of lead from gasoline.

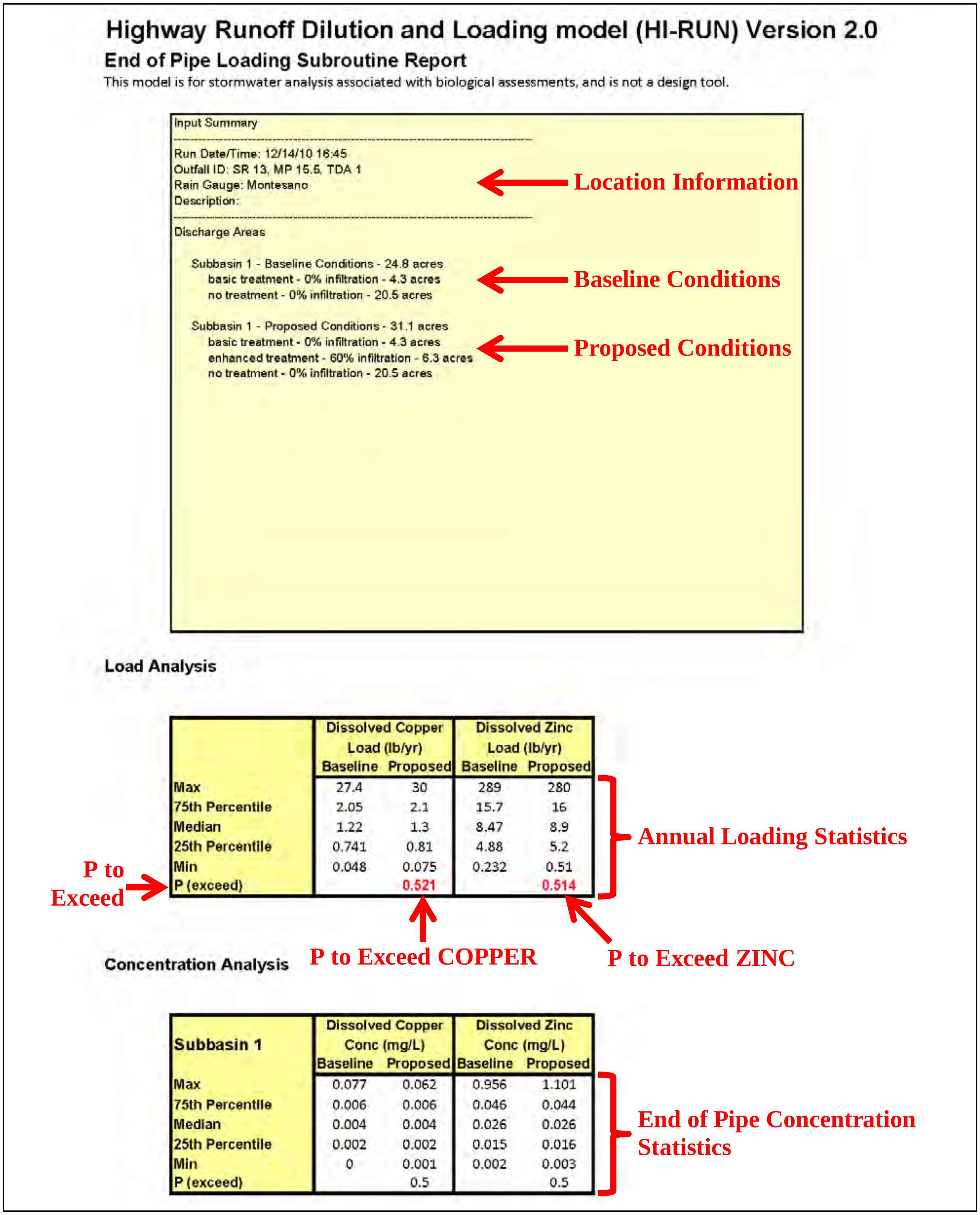
WSDOT is currently not analyzing for these other pollutants in their stormwater runoff. The five pollutants of concern (TSS, total and dissolved zinc and copper) are serving as indicators of pollutant loads for all stormwater pollutants and for evaluating removal efficiencies of the stormwater treatment BMPs until new information becomes available.

Case Study #2. Completing the Dilution Subroutine

The hypothetical project evaluated in Case Study #2 has the following characteristics:

- Existing roadway area: 24.8 acres
- Existing treatment: biofiltration swale (sized for 4.3 acres)
- Proposed roadway area: 31.1 acres (6.3 additional acres)
- Proposed treatment: media filter drain (previously referred to as ecology embankments) sized for 6.3 new acres. Existing biofiltration swale remains (sized for 4.3 acres).
- Outfall: All runoff in the TDA discharges through a single outfall (only one subbasin).
- Incidental infiltration: Due to sufficient separation between the base of the media filter drain and the seasonal high water table elevation, it is determined that the facility will achieve approximately 60 percent infiltration on an annual runoff volume basis. The biofiltration swale is not expected to have substantial incidental infiltration.
- Detention: Detention is planned for this TDA to meet the Highway Runoff Manual flow control requirements.
- ESA-listed fish species present in the project receiving water includes Puget Sound Chinook salmon. An analysis will be performed to evaluate the potential water quality effects of highway runoff on rearing Chinook salmon in the months of August and September. If rearing Chinook are expected to be present during other months, those months should also be incuded in the analysis.
- Background water quality data from a site upstream of the project outfall is available from a previous watershed assessment effort. The median values for DCu and DZn are 0.002 and 0.003 mg/L, respectively.
- Receiving water quality indicators are properly functioning.

The model inputs for Case Study #2 are described in detail in the HI-RUN Users Guide, and the resulting output for the End-of-Pipe Loading Subroutine for Case Study #2 appears in Figure 17-4 below.



Highway Runoff Dilution and Loading model (HI-RUN) Version 2.0

End of Pipe Loading Subroutine Report

This model is for stormwater analysis associated with biological assessments, and is not a design tool.

Input Summary

Run Date/Time: 12/14/10 16:45
Outfall ID: SR 13, MP 15.5, TDA 1
Rain Gauge: Montesano
Description:

Discharge Areas

Subbasin 1 - Baseline Conditions - 24.8 acres
basic treatment - 0% infiltration - 4.3 acres
no treatment - 0% infiltration - 20.5 acres

Subbasin 1 - Proposed Conditions - 31.1 acres
basic treatment - 0% infiltration - 4.3 acres
enhanced treatment - 60% infiltration - 6.3 acres
no treatment - 0% infiltration - 20.5 acres

Load Analysis

	Dissolved Copper Load (lb/yr)		Dissolved Zinc Load (lb/yr)	
	Baseline	Proposed	Baseline	Proposed
Max	27.4	30	289	280
75th Percentile	2.05	2.1	15.7	16
Median	1.22	1.3	8.47	8.9
25th Percentile	0.741	0.81	4.88	5.2
Min	0.048	0.075	0.232	0.51
P (exceed)		0.521		0.514

Concentration Analysis

Subbasin 1	Dissolved Copper Conc (mg/L)		Dissolved Zinc Conc (mg/L)	
	Baseline	Proposed	Baseline	Proposed
Max	0.077	0.062	0.956	1.101
75th Percentile	0.006	0.006	0.046	0.044
Median	0.004	0.004	0.026	0.026
25th Percentile	0.002	0.002	0.015	0.016
Min	0	0.001	0.002	0.003
P (exceed)		0.5		0.5

Figure 17-4. End-of-pipe loading subroutine summary results – Case Study #2.

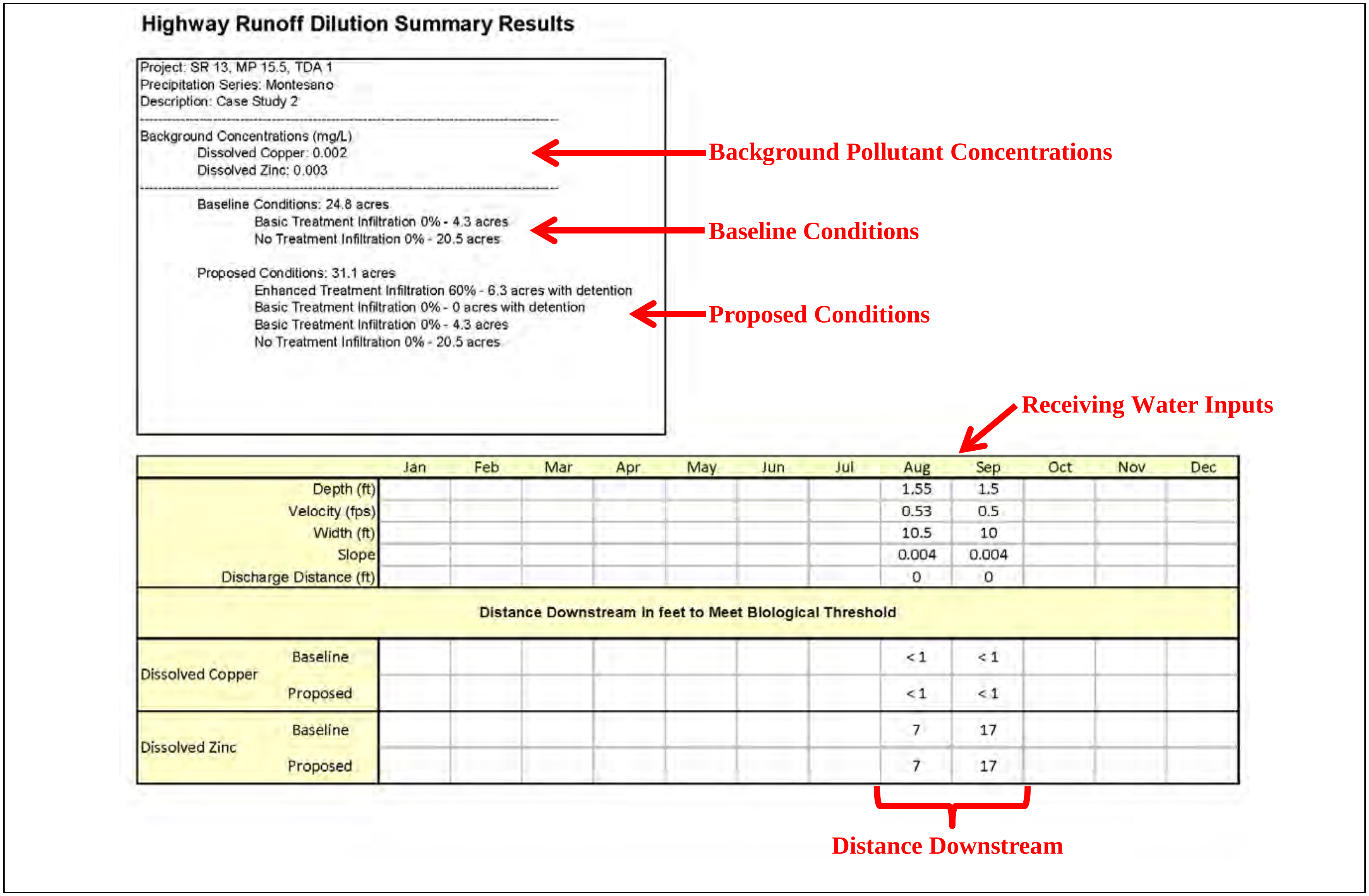
The P(exceed) value for dissolved zinc loading is 0.514. Because this P(exceed) value is greater than the 0.45 threshold depicted on Figure 17-2 , a detailed dilution analysis using the receiving water dilution subroutine must be conducted as a next step.

The model output should be provided in an appendix to the BA. But the results from the model output should be summarized within the BA. The P(exceed) values and additional summary statistics would be used by the biologist in the BA as described in Case Study #1 to generally describe the difference between the post-project and existing conditions with regard to water quality. This discussion would be followed by a more rigorous description of project-related effects generated from the HI-RUN Receiving Water Dilution Subroutine results.

The inputs for the HI-RUN Receiving Water Dilution Subroutine, are provided for Case Study #2 in the HI-RUN Users Guide. The summary output generated by the model (Figure 17-5), indicates that the biological threshold for zinc would be exceeded at distance of up to 17 feet downstream of the outfall in both existing and proposed conditions during the month of September, while the biological thresholds would only be exceeded at a distance of up to 7 feet was for both conditions during the month of August. The biological threshold for dissolved copper is not estimated to be exceeded at distance of greater than 1 foot from the outfall for both the existing and proposed conditions; this is the minimum distance that HI-RUN will evaluate. A modified version of the HI-RUN model is available upon request for providing water quality input data to the CORMIX model. For contact information, see the WSDOT website:
<http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#Stormwater>.

The maximum distance downstream during any month defines the area within which ESA-listed aquatic species could be exposed to pollutant concentrations sufficient to cause adverse sub-lethal effects. In the example output from Case Study #2 (Figure 17-5), this distance is 17 feet for the month of September. This information would then be considered by the author of the biological assessment when making a stormwater-related effect determination. However, it must be stressed that this output is intended to provide a general assessment of the risk for pollutant exposure for ESA-listed species from highway runoff. Other potential stormwater effects (e.g., loading impacts and flow-related effects) are identified in the HI-RUN end-of-pipe loading subroutine and in the procedure outlined above for analyzing effects on flow conditions and local hydrology, respectively.

Where this assessment indicates a potential risk exists, a more detailed assessment (quantitative or qualitative) of the project should be performed to determine whether there are mitigating factors that are not reflected in the output of the HI-RUN model (see Step 7 below). Step 7 below summarizes factors that would be considered when completing this assessment. In general this assessment would examine potential site characteristics not addressed in the HI-RUN model that influence water quality or flow impacts (i.e., open conveyance, distance from outfall to receiving waterbody), quality and suitability of habitat within the receiving waterbody for various lifestages of species, and anticipated timing of discharges relative to the anticipated use and timing of species in the receiving waterbody.



Highway Runoff Dilution Summary Results

Project: SR 13, MP 15.5, TDA 1
Precipitation Series: Montesano
Description: Case Study 2

Background Concentrations (mg/L)
Dissolved Copper: 0.002
Dissolved Zinc: 0.003

Baseline Conditions: 24.8 acres
Basic Treatment Infiltration 0% - 4.3 acres
No Treatment Infiltration 0% - 20.5 acres

Proposed Conditions: 31.1 acres
Enhanced Treatment Infiltration 60% - 6.3 acres with detention
Basic Treatment Infiltration 0% - 0 acres with detention
Basic Treatment Infiltration 0% - 4.3 acres
No Treatment Infiltration 0% - 20.5 acres

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Depth (ft)								1.55	1.5			
	Velocity (fps)								0.53	0.5			
	Width (ft)								10.5	10			
	Slope								0.004	0.004			
	Discharge Distance (ft)								0	0			
Distance Downstream in feet to Meet Biological Threshold													
Dissolved Copper	Baseline								< 1	< 1			
	Proposed								< 1	< 1			
Dissolved Zinc	Baseline								7	17			
	Proposed								7	17			

Figure 17-5. Overview of detailed receiving water dilution subroutine results – Case Study #2.

The HI-RUN model automatically calculates the adverse sub-lethal effect thresholds for dissolved zinc and copper, based upon the background concentrations of these metals in the receiving waterbody (Figure 17-5). The dissolved copper and dissolved zinc existing concentrations and concentrations resulting in the post-project condition are presented relative to the adverse sub-lethal effect thresholds, above which, adverse sub-lethal effects may occur:

- The current adverse sub-lethal effect threshold for DZn is 5.6 µg/L over background zinc concentrations between 3.0 µg/L and 13 µg/L (Sprague 1968).
- The HI-RUN model currently calibrates to the receiving water's actual background concentration regardless of whether it falls within the range provided by the threshold described above. Model outputs will automatically calculate a 0.0056 mg/L (5.6 microgram/liter) increase in DZn over the receiving water's background concentration.
- The adverse sub-lethal effect threshold for DCu is 2.0 µg/L over background levels of 3.0 µg/L or less (Sandahl et al. 2007).
- The HI-RUN model currently calibrates to the receiving water's actual background concentration regardless of whether it falls below a background of 3.0 µg/L or less. Model outputs will automatically calculate a 0.002 mg/L (2.0 microgram/liter) increase in DCu over the receiving water's background concentration.
- 1 mg/L (milligram per liter) = 1,000 µg/L (micrograms per liter). To convert model outputs from mg/l to µg/L, move the decimal place three places to the right.

The model output should be provided in an appendix to the BA. But the results from the model output should be summarized within the BA. Table 17-7 provides a generalized format summarizing these data for each individual parameter. Note this table presents purely hypothetical data and does not directly incorporate results from Case Study #2. Values in this table represent distances downstream from the outfall (in feet) where receiving water concentrations will exceed the applicable threshold for biological effects with a 5 percent probability. Separate values are presented for the proposed and existing conditions, respectively.

Table 17-7. Example table format for summarizing results from dilution analyses performed using the HI-RUN dilution subroutine.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAX
Species A	7/6	5/4	4/3	8/7							7/6	8/7	8/7
Species B			4/3	8/7	9/7	10/9							10/9
Species C	7/6	5/4	4/3	8/7	9/7	10/9	8/7	5/4	6/5	5/4	7/6	8/7	10/9
Species D	7/6	5/4	4/3	8/7							7/6	8/7	8/7

Existing condition/proposed condition

In the detailed model output, the left-hand column for both existing and proposed conditions is highlighted in green. This column depicts the probability of concentrations falling within the following ranges:

- The bottom row: Zero to the background (established by the biologist and/or project hydrologist based upon available existing water quality data) (Figure 17-6)
- The middle row: Background to the biological threshold (for dissolved copper or zinc) (Figure 17-6)
- The top row: Above the biological threshold (for dissolved copper or zinc) (Figure 17-6)

By providing summary data for pollutant concentrations in this way, the model allows the biologist to effectively describe the potential for biological thresholds to be exceeded between the established point of interest downstream of the project and the discharge point or outfall. For example, based upon the output for existing conditions provided above, concentrations of dissolved copper in a given runoff event during the month of August have a 0.6 percent probability of exceeding the biological threshold and a 1 percent probability in September (Figure 17-6). Similarly, for dissolved zinc, there is a 2.6 percent probability that concentrations will exceed the biological threshold during a runoff event in the month of August and a 4.7 percent probability in September (Figure 17-6). For the proposed condition, there is a 0.5 percent probability that concentrations of dissolved copper will exceed the biological threshold during a runoff event in the month of August and a 1 percent probability in September (Figure 17-7). Similarly, for dissolved zinc, there is a 2.4 percent probability that concentrations will exceed the biological threshold during a runoff event in the month of August and a 4.6 percent probability in September (Figure 17-7).

The model outputs also describe the potential for different ranges of discharge durations (the cells along the bottom of the output tables highlighted in green) occurring in a given month (taking into account the proposed BMPs and how they affect discharge within the TDA). The biologist can use this information to help describe the likelihood that a discharge event of a given duration will occur. The biologist can also examine the probability of certain concentration ranges occurring during discharge events of specific duration. This helps to describe how long fish may be exposed.

The biologist should summarize and discuss the results of the stormwater analysis in the "Analysis of Effects" section as follows:

- Describe project-generated differences in the pre- and post-project loading; compare loading estimates
- Analyze the location of the outfall/discharge point and the modeled zone of effect (distance downstream to the point of interest) relative to habitat suitability, species occurrence, and timing of the species relative to when

4.7 percent probability of exceeding copper biological threshold – baseline conditions

Dissolved Copper - September probability of occurrence for baseline conditions downstream distance = 1 feet

Baseline Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.004	0.047	0.006	0.013	0.015	0.009	0.003	0.001	0.000	0.000
0.002 - 0.004	0.775	0.094	0.220	0.247	0.152	0.051	0.010	0.001	0.000
0 - 0.002	0.178	0.022	0.051	0.057	0.035	0.012	0.002	0.000	0.000
		0.121	0.284	0.319	0.196	0.066	0.013	0.001	0.000

Proposed Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.004	0.081	0.000	0.001	0.005	0.016	0.027	0.022	0.009	0.002
0.002 - 0.004	0.771	0.000	0.006	0.044	0.155	0.255	0.208	0.084	0.018
0 - 0.002	0.147	0.000	0.001	0.008	0.030	0.049	0.040	0.016	0.004
		0.000	0.008	0.057	0.202	0.331	0.270	0.108	0.024

Discharge Duration (hrs)

4.6 percent probability of exceeding copper biological threshold – baseline conditions

Dissolved Copper - September probability of occurrence for proposed conditions downstream distance = 1 feet

Baseline Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.004	0.081	0.010	0.023	0.026	0.016	0.005	0.001	0.000	0.000
0.002 - 0.004	0.741	0.090	0.207	0.237	0.145	0.050	0.010	0.001	0.000
0 - 0.002	0.178	0.022	0.050	0.057	0.035	0.012	0.002	0.000	0.000
		0.121	0.280	0.321	0.196	0.067	0.014	0.001	0.000

Proposed Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.004	0.046	0.000	0.000	0.003	0.009	0.015	0.013	0.005	0.001
0.002 - 0.004	0.807	0.000	0.006	0.047	0.163	0.266	0.218	0.088	0.019
0 - 0.002	0.147	0.000	0.001	0.009	0.030	0.048	0.040	0.016	0.003
		0.000	0.007	0.058	0.202	0.330	0.270	0.109	0.023

Discharge Duration (hrs)

4.9 percent probability of exceeding zinc biological threshold – baseline conditions

Dissolved Zinc - September probability of occurrence for baseline conditions downstream distance = 17 feet

Baseline Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.0086	0.049	0.006	0.014	0.016	0.010	0.003	0.001	0.000	0.000
0.003 - 0.0086	0.950	0.115	0.267	0.303	0.187	0.064	0.013	0.001	0.000
0 - 0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.121	0.281	0.319	0.197	0.067	0.014	0.001	0.000

Proposed Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.0086	0.029	0.000	0.000	0.002	0.006	0.010	0.008	0.003	0.001
0.003 - 0.0086	0.971	0.000	0.007	0.056	0.195	0.322	0.261	0.107	0.022
0 - 0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.008	0.057	0.201	0.331	0.269	0.110	0.023

Discharge Duration (hrs)

4.9 percent probability of exceeding zinc biological threshold – baseline conditions

Dissolved Zinc - September probability of occurrence for proposed conditions downstream distance = 17 feet

Baseline Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.0086	0.031	0.004	0.009	0.010	0.006	0.002	0.000	0.000	0.000
0.003 - 0.0086	0.967	0.117	0.277	0.308	0.187	0.065	0.013	0.001	0.000
0 - 0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.121	0.286	0.318	0.193	0.067	0.014	0.002	0.000

Proposed Conditions

Conc. (mg/L)	Total	0 - 3	3 - 6	6 - 12	12 - 24	24 - 48	48 - 96	96 - 192	>192
> 0.0086	0.049	0.000	0.000	0.003	0.010	0.016	0.013	0.005	0.001
0.003 - 0.0086	0.951	0.000	0.007	0.055	0.193	0.316	0.254	0.103	0.024
0 - 0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.007	0.058	0.202	0.332	0.267	0.109	0.025

Discharge Duration (hrs)

Figure 17-6. Detailed receiving water dilution subroutine results – Case Study #2.

and where stormwater discharges are anticipated to evaluate the potential for exposure

- If there is potential for exposure, the biologist would include general discussions on 1) the anticipated timing and duration of exposure (based upon the HI-RUN model outputs regarding probability of occurrence for storm events of various durations – see Figure 17-6), 2) the potential response of species or critical habitat to increased or decreased pollutant loads (based upon guidance provided in Case Study #1 regarding loading), and 3) toxicity related to the anticipated pollutant concentrations (based upon general information regarding effects of stormwater constituents on fish provided earlier in this chapter and the guidance provided in the paragraph immediately below).

In general, changes in pollutant concentrations can result in direct lethal and sublethal effects to listed aquatic species via absorption from gill surfaces, olfactory inhibition, and ingestion. If a project alters the concentrations of pollutants, the biologist must first compare projected concentrations to known biological threshold concentrations for dissolved zinc and copper to determine if there is potential for injury to an individual fish. The biologist then considers any changes in concentrations in an environmental context (see Step 7 below) to further define or characterize the potential for exposure or injury to occur. For example the biologist would consider current baseline water quality conditions in relation to the projected concentrations; the anticipated extent of altered concentrations in the receiving water body (the dilution zone) in relation to the habitat type(s) that would be exposed to altered concentration; and finally what life stage(s) could be exposed to altered concentrations based upon when, how long, and how frequently exposure would occur.

The toxicity of the stormwater constituents is species-specific and effects may be visible at various levels of biological organization (i.e., on a molecular, cellular, tissue, or whole-organism level). Often, research has not been conducted on ESA-listed species and results must be extrapolated based on physiological and environmental similarities. Laboratory studies are useful due to the ability to control for multiple variables, thus providing the ability to determine cause-and-effect relationships.

However, the laboratory studies have not been verified with field studies. Currently there is limited peer reviewed science on the effects of pollutants of concern on listed species in the natural environment. The focus of the BA analysis will be on the changes the project is having on the existing conditions and on the potential for exposure for listed species to concentrations exceeding the established biological thresholds.

17.2.7 Step 7: Examine Site-Specific Conditions that May Lessen or Magnify Stormwater Effects

In some cases, site-specific conditions may help to lessen or may magnify the predicted effects. Qualitative or quantitative factors to consider and that may influence potential stormwater impacts include:

- Soils that support infiltration: Soils that support infiltration will reduce the amount of stormwater that reaches the receiving waterbody. Soil information can be accessed at the following websites: <http://remotesens.css.wsu.edu/washingtonsoil/> and <http://www.or.nrcs.usda.gov/pnw_soil/wa_reports.html>.

- Outfall configuration: Is it a single pipe? Does it end in a diffuser or flow spreader that could increase dilution (and therefore decrease pollutant concentrations) within the receiving waterbody?

- Runoff conveyance characteristics: Is it a closed system with no opportunity for evapo-transportation or infiltration, or does runoff flow through a broad/unlined/open channel?

- Distance from the outfall to a receiving waterbody: If the outlet does not end directly at a riprap pad within the OHWL of the receiving waterbody, then there is the opportunity for dispersion and infiltration of flows. The longer the distance from the receiving waterbody, the greater the opportunity for dispersion, evaporation, infiltration and even additional treatment through the interaction of the stormwater with soils and vegetation. This factor may be considerably less important under “wet season” conditions when soils are saturated.

- Characteristics of the receiving waterbody: Is it an ephemeral channel? Is the point of discharge within a wetland or riparian buffer? Is the wetland reliant upon stormwater discharges to maintain its hydrology? Is it an emergent wetland that will provide additional treatment and mixing prior to discharging to the receiving water body? Is the wetland and/or receiving waterbody used by fish for habitat? All of these considerations will influence potential effects and exposure.

- Does the outfall or project discharge to a dynamic fast moving receiving water body or to a slower moving receiving waterbody? If the outfall or project discharge is to a slow moving or tidally influenced waterbody, a different mixing model (i.e., CORMIX) will need to be used to determine the potential for exposure to stormwater concentrations in exceedance of biological effect thresholds. Describe the temporal and spatial effects this condition could have on potential exposure.

All of these factors working individually or together can influence the amount and quality of the stormwater prior to it entering the receiving water.

Similarly, site-specific factors related to habitat and species in the receiving water need to be reconsidered in light of this additional information in order to accurately assess and describe anticipated exposures. The significance of these site-specific factors, is that they potentially affect:

- Quality and suitability of habitat within the receiving waterbody for various lifestages of species resulting from project-related impacts to water quality, flow, or local hydrology
- Anticipated timing of discharges relative to the anticipated use and timing of species in the receiving waterbody
- Potential exposure(s) and anticipated response(s) of fish to stormwater concentrations in exceedance of biological effect thresholds.

17.2.8 Step 8: Revisit Action Area Extent to Reflect Effects from Stormwater BMP Construction and Stormwater Runoff.

The project biologist will not be able to complete this step until after stormwater effects have been identified and their physical, chemical and biological effects assessed. This includes the stormwater effects associated with the induced growth. It is important to remember from the outset that stormwater is only one component used in defining the action area. The project biologist will need to revisit how the action area has been defined as the anticipated effects associated with various project elements are more fully understood or more accurately estimated (see CHAPTER 8 – ACTION AREA).

17.2.9 Step 9: Assess Potential Exposure and Response of Species and Critical Habitat

The biologist must evaluate all of the direct and indirect effects resulting from the proposed stormwater management and designs when providing rationale in support of stormwater-related effect determinations for listed species and critical habitat. This requires the biologist fully integrate all of the preceding steps into a coherent analysis and discussion. The biologist must consider all of the stormwater effects and risks for exposure identified in Step 6 (Section 17.2.6) and modified in Step 7 (Section 17.2.7), taking into consideration the biology of the species and habitat (Step 4 – Section 17.2.4), within the context of existing conditions identified in Step 5 (Section 17.2.5).

- The project may result in insignificant, incremental or significant effects, and may persistently or episodically affect pollutant loads, pollutant concentrations, flow and/or local hydrology. The biologist must consider all of these short- and long-term effects.

- The biologist must assess whether, how, and where listed species or their habitat may be exposed (temporally and spatially) to these direct and indirect effects and how they affect conditions in the receiving waters over time.
- The biologist must describe how listed species (individuals) or their habitat will respond to exposure:
  - Will individuals experience significant disruption to their normal behaviors (feeding, moving, or sheltering) or essential behaviors (spawning, egg incubation, etc.)?
  - Will habitat conditions be altered in a way(s) that measurably affect suitability and function for the listed species?
- The biologist must evaluate whether anticipated project-related effects to existing conditions within the receiving waterbody will influence the potential for exposure, and the projected responses of listed species and their habitat.

17.2.10Step 10: Factor Stormwater Impacts into Effect Determinations

The BA provides a single effect determination for each listed species, which take into account the effects of the entire project including stormwater discharges and new and modified stormwater elements. As a preliminary step in reaching that determination, the project biologist focuses on assessing just the stormwater effects (i.e., changes to the pattern or rate of runoff, peak flows, flow durations, and base flow, as well as changes in pollutant loads and pollutant concentrations) and makes an effect determination for each species or habitat related to anticipated stormwater effects. However, these stormwater-specific effect determinations are then considered in conjunction with all of the effect determinations generated for other project elements (e.g., noise, in-water work, indirect effects, etc.) to arrive at a single overall effect determination for each species addressed in the BA.

17.2.10.1 Effect Determinations for Listed Species and Designated Critical Habitat

Determination of No-Effect Based on No Exposure

If listed habitat and species utilization areas do not temporally or spatially overlap with the areas that will be affected by changes in stormwater pollutant loading, water quality, flow, local hydrology or areas that lie within the BMP or conveyance system footprint (including the outfall), then the species and habitat will not be exposed. Projects that result in no net increase of pollutants to the receiving water and have no effect on flow and local hydrology in the receiving water will have no stormwater impacts on listed species or habitat. If species or habitat is not exposed to the stormwater discharges or new or modified BMPs and related infrastructure, a *no-effect* determination is warranted for this element of the project. Remember that the overall effect determination for each species is based on effects of the entire project, not just the stormwater discharges and stormwater and infrastructure.

Determination of May Affect, Not Likely to Adversely Affect

Where the effects of the stormwater discharges and proposed stormwater designs (i.e., BMPs, conveyance, points-of-discharge) on a listed species or habitat are judged to be beneficial, discountable, or insignificant, a *may affect, not likely to adversely affect* determination is warranted for the stormwater element of the project. Stormwater effects that are beneficial, discountable, or insignificant will be dependent upon project conditions, receiving waterbodies, stormwater treatment levels, existing conditions, and presence of species or habitat.

A project biologist who has reached this effect determination has provided all the analysis required and has clearly outlined any stormwater effects (i.e., changes in water quality, flow and local hydrology), the footprint of the BMPs, outfall locations, conveyance system characteristics and potential for influencing project stormwater effects, and temporary and permanent effects. The project biologist has also identified the habitat availability and historical use by the species in the action area and relative to the anticipated temporal and spatial extent of stormwater effects, and has documented the extent of exposure in the effects analysis. All predicted effects have been adequately supported and identified as beneficial, discountable, or insignificant (see discussion of each of these terms below) in the effects analysis.

Beneficial Effects

A beneficial effect (without any adverse effects) does not qualify for a *no-effect* determination. If the proposed stormwater design will have only beneficial effects and no adverse effects on a listed species or habitat, then a *may affect, not likely to adversely affect* determination is warranted for the stormwater element of the project. For example, if a project will result in decreases in both pollutant loadings and concentrations, the project would provide a beneficial effect related to water quality.

Discountable Effects

If the project biologist determines that exposure to stormwater-related effects is extremely unlikely to occur, and this can be supported with best available science, then the effect is discountable. For example, effects related to changes in water quality may be discountable if the species is extremely unlikely to be present when stormwater discharges will occur (i.e., there is little chance for exposure to occur). The rationale for concluding that the effects are discountable must be explained in the effects analysis. Where the effects are discountable, *a may affect, not likely to adversely affect* determination is warranted for the stormwater element of the project.

Insignificant Effects

Perhaps exposure to the stormwater-related effects is likely, but the response of the listed species or habitat is expected to be so small that it cannot be meaningfully measured, detected, or evaluated. The project biologist could infer this if the probability of pollutant concentrations exceeding the established biological thresholds is extremely low (i.e., less than 1 percent),and/or if changes to annual pollutant loads, flows or local hydrology relative to existing conditions are negligible (i.e., predicted plume size is extremely small or discharges will be infrequent). In each of these cases, the project biologist should explain the rationale for concluding that the effects are insignificant in the effects analysis. Where the effects are insignificant, a *may affect, not likely to adversely affect* determination is warranted.

Determination of May Affect, Likely to Adversely Affect

Effects on listed species and critical habitat that are not beneficial, discountable, or insignificant warrant a *may affect, likely to adversely affect* determination for the stormwater element of the project.

Quantifying Adverse Effects on Species

If an effect is not beneficial, discountable, or insignificant, then it is an adverse effect. Adverse effects can be either direct impacts on the listed species or indirect impacts on its habitat or prey species. Stormwater impacts that result in measurable adverse effects to listed species or critical habitat may include changes to the pattern or rate of runoff, peak flows, flow durations, and base flow, as well as changes in pollutant loads and pollutant concentrations that result from projects that create significant amounts of pollution generating impervious surface and/or projects that occur in watersheds with degraded baseline or existing conditions. These assessments must be supported by pertinent existing information on the habitat elements, species life history, and number of individuals and life stages that may be affected.

Stormwater-related effects that are likely to affect an individual animal's ability to seek shelter, forage, move freely, reproduce, or survive result in *take*. These are the endpoints used to quantify or describe the adverse effect on a species.

A project biologist who has reached this effect determination has provided all the content recommended in Section 17.2 and has clearly outlined the existing and proposed stormwater treatment and design in the project description, including temporary and permanent facilities, outfall locations, and existing and proposed conveyance. The project biologist has also identified the habitat availability and historical use by the species, and has described the relevant water quality indicators and habitat characteristics in the existing environmental conditions, and has documented the spatial and temporal extent of exposure of the stormwater and proposed stormwater discharges and BMPs in the effects analysis. All predicted impacts on an individual animal's ability to survive, reproduce, move freely, forage, or seek shelter are supported with best available science and are addressed in the effects analysis.

17.2.10.2 Effect Determinations for Proposed Species or Proposed Critical Habitats

Jeopardy Determination

If an adverse effect is significant enough (i.e., if an entire subpopulation will be adversely affected), then the proposed action may jeopardize the continued existence of the species. A jeopardy determination applies only to species that are *proposed* for listing under the ESA. For a negative jeopardy determination, the BA includes the statement "The project is not likely to jeopardize the continued existence of the species."

A project biologist who believes that a project might jeopardize a proposed species should consult the WSDOT Environmental Office.

Adverse Modification Determination

An adverse effect is considered an *adverse modification* if it destroys the conservation role of the critical habitat for a species. An adverse modification determination applies to proposed or designated critical habitat units. For a negative adverse modification determination, the BA includes the statement "The project is not likely to adversely modify the critical habitat unit."

It is possible for a project to have an adverse effect on any or all of the primary constituent elements yet not reach the level of an adverse modification to the critical habitat unit. A project biologist who believes that a project might adversely modify a critical habitat unit should consult the WSDOT Environmental Office.

17.3 Indirect Effects Stormwater Runoff Analytical Method

In January 2011, the multi-agency Project Management Team (PMT) (consisting of representatives from U.S. Fish and Wildlife Service, National Marine Fisheries Service, Federal Highway Administration, and Washington State Department of Transportation (WSDOT) developed guidance for assessing stormwater quality impacts from development-related indirect effects that can be directly associated with a transportation project. The *Indirect Effects Stormwater Runoff Analytical Method* serves as an addition to the guidance presented in the technical memorandum issued on June 17, 2009 by the PMT titled *Endangered Species Act (ESA), Transportation and Development; Assessing Indirect Effects in Biological Assessments*.

The method is intended to provide a coarse scale analysis of the changes in annual loads for three stormwater pollutants from changes in land use and or impervious surface. This method should only be used to assess development related indirect effects that can be directly associated with a transportation project per the Project Management Team technical memorandum. It should also be noted that this method does not address potential changes in stormwater quantity from development related indirect effects.

This method is a simple "wash-off" model that relies upon unit area annual pollutant loads (pounds/acre/year) for individual land uses to predict annual pollutant yields (pounds/year) from the changes in land use associated with the indirect effects of the project for the existing and projected conditions following completion of the transportation project. It is based upon Method 2: Applying Literature Values as described in the 2009 WSDOT guidance document, *Quantitative Procedures for Surface Water Impact Assessments*, but it replaces the land use type categories and annual pollutant loading rates used in Method 2 with more current data that is specific to Western Washington. As a result, this method is only applicable to projects in Western Washington.

The model utilizes unit area annual pollutant loads for three parameters (total suspended solids, total zinc, and total copper) and the following four land use types:

- Forest: generally refers to second growth coniferous forests with only minor commercial timber harvesting activities.
- Agricultural: generally refers to irrigated cropland for food production and low to medium density livestock grazing.
- Low- to Medium Density Development: generally refers to low and medium density single family residential development with one to six dwellings per acre.
- High-Density Development: generally refers to commercial, industrial, multi-family residential development and/or high density single family residential development (> six dwellings per acre).

The method is available on the WSDOT website at <http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#Stormwater>.

17.3.1 Steps for Analyzing Annual Pollutant Loadings Associated with Development Related Indirect Effects

1. First identify the areas within the action area that will be changed as an indirect effect of the proposed project (see PMT technical memorandum cited above).

2. For the existing condition, estimate the area (in acres) of land, within the portion of the action area that will be changed that is currently represented by each land use type in Table 1.

3. Multiply the area for each land use type by the appropriate unit area loading rate in Table 1 for that land use to obtain annual load estimates for each land use type under the existing condition. An example of how these calculations are performed is provided in Attachment B.

4. Add the annual load estimates for all land use types to produce an estimate of the total load from changed portion of the action area under the existing condition.

5. For the projected condition following completion of the transportation project (or each proposed alternative for the project), estimate the number of acres of land, within the portion of the action area that will be changed, that will be represented by each land use type in Table 1. An example of how these calculations are performed is provided in Attachment B.

6. Multiply the area for each land use type by the appropriate unit area loading rate in Table 1 for that land use to obtain annual load estimates for each land use type under the projected condition.

7. Add the annual load estimates for all land use types to produce an estimate of the total load from the changed portion of the action area under the projected condition.

Note, if there are multiple basins or receiving waters within the action area that will be affected by development-related indirect effects from the proposed transportation project or project alternatives, it may be necessary to provide additional tables depicting how many acres will be affected in each of these individual basins and to quantify the annual loading effects of each alternative on each basin, in addition to the overall action area. To do this, the biologist would need to complete the following additional steps:

8. In order to calculate areas for each land use type by basin, the biologist would need to determine the extent of the drainage basin /receiving water basin. The total basin area, for each basin, can be delineated using the on-line GIS-based tool StreamStats, developed by USGS: <http://water.usgs.gov/osw/streamstats/index.html>.

9. Once the extent of the basin(s) has been established, the biologist would then determine the extent of each land use type within each basin.

10. As described in steps 1 through 6 above, calculations would be completed, by basin (rather than action area) for existing and projected conditions to discern the changes between existing and projected land use and loading conditions by basin.

Once the project-specific loading rates have been established for the existing and projected conditions within the action area, the biologist can analyze changes in land use and loading by comparing the differences between the areal extent of land uses and associated loading within the action area between the existing and projected conditions. The biologist should summarize these results within the indirect effects section of the biological assessment and provide a qualitative discussion regarding chemical, biological and ecological effects of stormwater runoff pollutant loadings.

In general, changes in loading affect baseline conditions in the receiving water body, which in turn may affect the suitability of habitat for listed species. Increased pollutant loads contribute to the continued or increased degradation of baseline water quality conditions. Conversely, decreased loads contribute to improvement of baseline conditions. Though changes in loading may contribute to sublethal effects to listed aquatic species via ingestion or food chain interactions, these changes can rarely be linked directly to injury of listed aquatic species. As a result, the indirect effects analysis above will allow the biologist to generally characterize potential changes to baseline conditions not to describe potential direct effects to fish.

17.4 On-line Resources for Stormwater

17.4.1 WSDOT Resources

WSDOT *Highway Runoff Manual*
<http://www.wsdot.wa.gov/Environment/WaterQuality/Runoff/HighwayRunoffManual>.

Exempt Surface Waters List (table 3-5 in the WSDOT *Highway Runoff Manual*)
<http://www.wsdot.wa.gov/publications/manuals/fulltext/M31-16/chapter3.pdf>.

WSDOT NPDES Progress Reports
<http://www.wsdot.wa.gov/Environment/WaterQuality/default.htm#reports>.

17.4.2 Existing Soil/Water Quality and Stream Flow Information

Washington Ecology – River and Stream Water Quality Monitoring
<http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html>.

Washington Ecology – Environmental Information Management
<http://www.ecy.wa.gov/eim/>

Snohomish County – Surface Water On-line Data
<http://198.238.192.103/spw_swhydro/wq-search.asp>.

USGS National Water Quality Assessment Program – Data Warehouse
<http://infotrek.er.usgs.gov/traverse/f?p=NAWQA:HOME:7497878595394337582>.

Washington State's Water Quality Assessment
<http://www.ecy.wa.gov/programs/wq/303d/2002/2002-index.html>.

Department of Ecology 303d List
< http://www.ecy.wa.gov/programs/wq/303d/index.html>.

Limiting Factors Analysis by Washington State Conservation Commission
< http://salmon.scc.wa.gov/>.

Background Soil Metals Concentrations for Washington State
Publication #94-115
<http://www.ecy.wa.gov/pubs/94115.pdf>.

17.4.3 Water Quality Standards

U.S. EPA Water Quality Standards
<http://www.epa.gov/waterscience/standards/>.

State Water Quality Standards
<http://www.ecy.wa.gov/programs/wq/swqs/new-rule.html>.

17.4.4 Current Research

WSDOT – Current Stormwater Research
<http://www.wsdot.wa.gov/environment/stormwater/default.htm>.

USGS National Water Quality Assessment Program
<http://water.usgs.gov/nawqa/>.

USGS National Highway Runoff
Water-Quality Data and Methodology Synthesis
<http://ma.water.usgs.gov/fhwa/biblio/default.htm>.

Washington Ecology – Whole Effluent Toxicity (WET) Testing
<http://www.epa.gov/waterscience/standards/>.

Northwest Fisheries Science Center
<http://www.nwfsc.noaa.gov/publications/displayinclude.cfm?incfile=journalarticlein_press.inc>.

Society of Environmental Toxicology and Chemistry (SETAC)
< http://www.setac.org/>.

Aquatic Toxicology journals – no specific on-line ability

Also see references provided in the HI-RUN Users Guide available on the WSDOT Environmental Website.