S Water Quality/Surface Water/Floodplains/ Groundwater Discipline Report

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SR 502 CORRIDOR WIDENING

IMPROVING SAFETY • INCREASING CAPACITY • REDUCING CONGESTION

I-5 TO BATTLE GROUND

FINAL

Water Quality / Surface Water / Floodplains / Groundwater Discipline Report

Prepared for:

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August 2008

Revised February 2009

This Project is also referred to as "SR 502/I-5 to Battle Ground – Add Lanes".

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Executive Summary

The purpose of this Executive Summary is to summarize the findings of the Final Water Quality / Surface Water / Floodplains / Groundwater Discipline Report for the SR 502 Corridor Widening Project.

What studies, methods and coordination were used to identify existing water resources in the study area?

Several studies, analyses, and technical memoranda were prepared for the project. These documents support the environmental evaluation presented in this discipline report (see sidebar). In addition to these technical reports reviewed, web-based resources from governing agencies were also used. Field reconnaissance and site visits confirmed data obtained from the above sources. Site photographs, aerial photographs, and maps were also reviewed. Contacts were made with Clark County regulatory agencies regarding streamflow monitoring data.

Technical Reports Reviewed

- SR 502 Preliminary Hydrology Analysis
- SR 502 Draft Wetland Discipline Report
- SR 502 Draft Biology Discipline Report

How were effects to water resources determined?

The Preliminary Hydrology Analysis and the *WSDOT Quantitative Procedures for Surface Water Impact Assessments* were the most pertinent data sets and reports for the analysis of water quality effects for this project. These two reports provide the basis for calculating the amount of transportation-related pollutants potentially entering the study area water bodies and quantify the amount of new pavement for the project.

Transportation-Related Pollutants

Total Suspended Solids (TSS)
Total and Dissolved Zinc
Total and Dissolved Copper

What are the existing water resource conditions in the study area?

Surface Water

The study area straddles the East Fork Lewis River Subbasin (Water Resource Inventory Area (WRIA) #27) and the Salmon Creek Subbasin (WRIA #28). Unnamed tributaries to Gee Creek are the surface water bodies that are within the western portion of the study area and associated with the East Fork Lewis River Subbasin. Mill Creek North and associated tributaries drain the central north portion of the study area directly to the East Fork Lewis River. Mill Creek, a tributary to Salmon Creek, is the surface wa-

ter body within the eastern and central south portion of the study area and is associated with the Salmon Creek Subbasin (Exhibit 1).

Exhibit 1 Subbasins in the Study Area

The East Fork Lewis River, Gee Creek, and Mill Creek are considered tributaries of the Lower Columbia River and contain listed and resident fish species.

Within the study area there may potentially be fish use in Mill Creek North and other unnamed tributaries to the East Fork Lewis River.

Within the study area there is no documented fish use of the unnamed tributaries to Gee Creek.

Within the study area there is documented fish use of Mill Creek. No known barriers to fish passage exist on Mill Creek within the project vicinity.

Floodplains

The primary source of flooding along the study area is Mill Creek. Mill Creek near its approach to Dollars Corner (the in-

tersection with SR 502 and NE 72nd Avenue) has undergone a detailed study with base flood elevations and a floodway developed. The detailed mapping of the 100-year floodplain associated with Mill Creek and a Mill Creek tributary immediately west of NE 72nd Avenue continues south past NE 179th Street. Mill Creek is the only waterway within the study area with mapped floodplains and adopted floodways.

Groundwater

A review of the well drilling logs for private land owners along the SR 502 corridor indicates that domestic-use groundwater is drawn from a depth of 41 to 88 feet below level ground in a layer of cemented and partially-cemented gravel. The shallower depths to groundwater occur between NE 50th Avenue and NE 72nd Avenue. Static water levels range from a depth of 23 to 88 feet below level ground, with the shallower depths also occurring between NE 50th Avenue and NE 72nd Avenue. A review of geotechnical borings in the study area shows that shallow groundwater is first encountered at about 6 feet below level ground and that soils in the vadose zone are characterized as moist to very wet.

Vadose Zone (also referred to as the unsaturated zone). It is the soil layer above the saturated zone (water table) and includes the capillary fringe of the water table. It may also include perched groundwater that is isolated from the regional water table.

What temporary effects to water resources would occur?

Surface Water

Portions of the proposed culvert extensions would affect areas below the Ordinary High Water Mark (OHWM) for three crossings of Mill Creek and for culvert replacements for Mill Creek and Mill Creek North. The existing streambed would be disrupted in order to attach the culvert extensions or pullout and install new culverts. The project would result in approximately 0.25 to 0.50 acres of disturbance below the OHWM for Mill Creek and Mill Creek North for three crossings. This estimate is based upon the area between the cut and fill lines for the expanded roadway prism and intersecting the OHWM for each water crossing.

Key Point – Total culvert work below OHWM for the Build Alternative would be between 0.25 and 0.50 acres

Erosion from exposed soils (either disturbed soil areas or soil stockpiles) during construction could increase the amount of sediment, suspended solids, and turbidity entering Mill Creek, Mill Creek North, unnamed tributaries to Gee Creek, and the East Fork Lewis River, and adjacent wetlands. No work is expected in erosion hazard zones as much of the study area is underlain by silt loam from various soil series with zero to eight percent slopes.

Clearing and grading would occur in the study area along the SR 502 corridor. These areas would be the sources for any potential water quality problems in addition to project staging areas. The locations of project staging areas are unknown at this point; however, staging areas can be sites of increased disturbance and erosion.

The construction season is not defined, but construction would likely occur during the summer. Because of low precipitation rates in the summer, waterways in the study area contain low flows. Due to the lower summer flows, erosion or contaminants that reach streams in the summer may represent a higher concentration relative to other times of the year.

Floodplains

During construction, the minor grading associated with the Build Alternative could potentially redirect and/or obstruct the flow of runoff or floodwaters. Once the grading is completed and the stormwater facilities operational, the potential temporary floodplain effects would be eliminated.

Groundwater

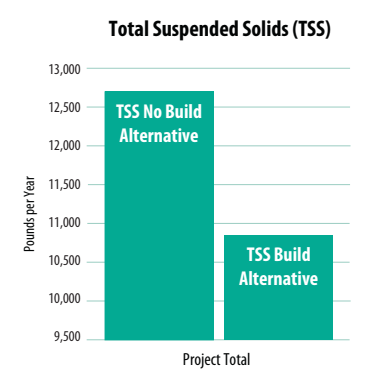
Construction activities that require vegetation clearing, soil compaction, and other practices that decrease the permeability of ground surface and impede infiltration of rainfall, can potentially affect groundwater resources. Spills from construction equipment, if not properly contained and cleaned-up, can enter and contaminate the shallow aquifer.

Key Point – The Build Alternative contributes to less than 1 percent of surface area runoff for all of the watersheds in the vicinity of the project.

What long-term effects to water resources would occur?

Surface Water

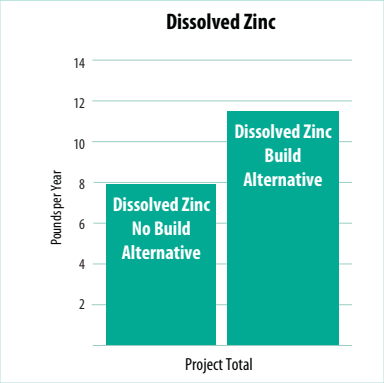
Currently, no stormwater treatment is provided for impervious surface within the action area. Under the Build Alternative, stormwater treatment and detention facilities would be constructed to treat stormwater runoff from impervious surfaces in the study area. At present, the study area includes approximately 23 acres of *existing* impervious surface. Initial calculations indicate that the project would create approximately 28 acres of *new* impervious surface for a total of approximately 51 acres of impervious surface. Stormwater treatment would treat all of the new impervious surface and approximately 6 acres of the existing impervious surface.



With the improved stormwater treatment associated with the project, the Build Alternative would result in a long-term im-

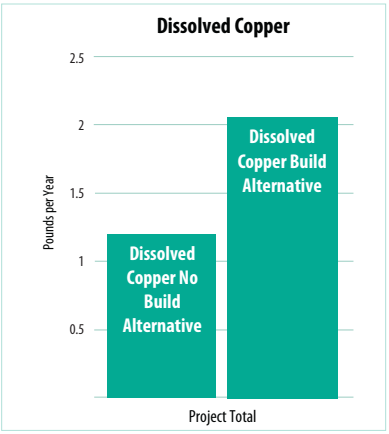
provement in water quality and quantity conditions within the study area due to the dramatic drop in TSS being discharged, and in turn, would likely result in a slight improvement in fish habitat quality of Mill Creek and Mill Creek North within the study area.

The slight increase in metals being discharged would likely not result in a decrease in fish habitat quality. The dilution modeling performed for the Biological Assessment shows that the metals concentrations would reach background levels within a few feet (or less) of entering the waterbodies.



Floodplains

As a result of construction, some fill would be placed within the floodplain of Mill Creek; however, due to relative flatness of the corridor, no major fills are proposed. The primary floodplain effects would occur just west of NE 67th Avenue for fill placed south and north of SR 502.



To accommodate Mill Creek and Mill Creek North, four structures are proposed to be modified or replaced. The two multi-plate culverts under SR 502 just west of NE 92nd Avenue would be replaced with a single fish-passable culvert. The box culvert under SR 502 just east of NE 72nd Avenue would be replaced, and the culvert under NE 72nd Avenue just south of SR 502 would also be replaced. In addition, the culvert under SR 502 west of NE 67th Avenue may be extended or replaced with a fish passable culvert.

The proposed fill for the SR 502 widening falls outside of the FEMA-designated floodway but within the 100-year floodplain on Mill Creek. While the proposed fill does remove some flood storage capacity, the fill would be placed in non-conveyance areas in contrast to removing conveyance from the creek's channel. The design will create compensatory flood storage to mitigate for the floodplain fill.

Groundwater

The net increase in impervious surface would not result in the diversion from groundwater infiltration to surface waters as the existing conditions assume no infiltration and all runoff reaches surface waters. This is not anticipated to reduce recharge to the shallow aquifer, nor will it affect the deeper aquifers or decrease water quality of the Troutdale Sole Source Aquifer, due to the confining silt and clay layer between the shallow and deep aquifers,

Mill Creek crossing of SR 502 at NE 92nd Avenue.

and the fact that most recharge areas occur east of the study area in the Cascade foothills.

What would be the effects to water resources if the project is not built?

Under the No Build Alternative, the existing SR 502 corridor would not be retrofitted with stormwater treatment, and stormwater runoff would continue to discharge as it does under existing conditions. No changes to the quality of groundwater resources due to roadway construction would occur. No changes in the flood storage capacity of the floodway of Mill Creek would occur.

What measures are proposed to minimize or avoid negative effects to water resources?

Stormwater treatment would be a part of the project. The proposed locations of water quality, water quantity best management practices (BMPs) for highway runoff as well as stormwater management requirements are described in the *Preliminary Hydrology Analysis Report* for the project. When possible, trees removed from the riparian areas could be salvaged and used for woody debris placement within environmental mitigation sites. Disturbed riparian areas will be seeded to improve water quality and planted with woody species to provide long-term bank stabilization and in-stream shading.

Spill control BMPs, including the Spill Prevention Control and Countermeasures (SPCC) Plan, proper storage, and containment facilities will be used during construction to minimize the effects of a spill. Contractors are required to prepare and implement the SPCC plan in accordance with WSDOT Standard Specification 1-07.15(1). Specific spill control BMPs can be found in Volume 2 of Ecology's Stormwater Runoff Manual for Western Washington. Effects due to erosion could be prevented by implementation of appropriate conservation measures in a temporary erosion sediment control (TESC) plan.

Because there are no existing stormwater treatment facilities, the project would retrofit approximately 6 acres of additional existing impervious surfaces for enhanced water quality treatment.

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1.0 Introduction

The SR 502 Corridor Widening Project is located in north Clark County, Washington along SR 502 (NE 219th Street) between NE 15th Avenue and NE 102nd Avenue. The western terminus of the project area is approximately one mile east of Interstate 5 (I-5) and the eastern terminus is NE 102nd Avenue. The project would widen an approximate five mile segment of SR 502 from two travel lanes to four travel lanes and upgrade several intersections to improve mobility and safety. Currently, SR 502 is a rural, two-lane highway. There is one signalized intersection at SR 502 and NE 72nd Avenue. For a more detailed description of the project, see the separate *Revised Description of Alternatives* document (Parsons Brinckerhoff, 2008d).

The purpose of this document is to describe the existing water quality, groundwater, surface water, and floodplains, discuss effects and benefits the project would have on those resources, and identify mitigation measures to address adverse effects as needed. The information contained in this discipline report will be used to support the project's Environmental Impact Statement (EIS).

2.0 Studies, Coordination, Methods, and Regulations

2.1 Surface Water

2.1.1 Summary of Baseline Documentation

The study area straddles the East Fork Lewis River Subbasin (Water Resource Inventory Area (WRIA) #27) and the Salmon Creek Subbasin (WRIA #28). Unnamed tributaries to Gee Creek are the surface water bodies that are within the western portion of the study area and associated with the East Fork Lewis River Subbasin. Mill Creek North and associated tributaries drain the central north portion of the study area directly to the East Fork Lewis River. Mill Creek, a tributary to Salmon Creek, is the surface water body within the eastern and central south portion of the study area and is associated with the Salmon Creek Subbasin.

East Fork Lewis River discharges to the mainstem of the Lewis River west of La Center, Washington. The Lewis River discharges to the Columbia River. As such, the East Fork Lewis River is considered a tributary of the Lower Columbia River and contains listed and resident fish species. Critical habitat is designated for the Lower Columbia steelhead and Chinook salmon, and Lower Columbia Chum salmon and bull trout in the East Fork Lewis River. Within the study area there may potentially be fish use in Mill Creek North and other unnamed tributaries to the East Fork Lewis River. Only Lower Columbia steelhead have designated critical habitat within the study area. Fish barriers downstream of NE 239th Street are present.

Gee Creek discharges to the Columbia River immediately upstream of the confluence of the Lewis and Columbia Rivers. As such, Gee Creek is considered a tributary of the Lower Columbia River and contains listed and resident fish species. Within the study area there is no documented fish use of the unnamed tributaries to Gee Creek due to fish barriers downstream of the study area including a partial barrier under I-5.

Mill Creek discharges into Salmon Creek, which in turn discharges into Lake River within the Ridgefield National Wildlife Refuge. Lake River joins the Columbia River upstream (south) of the Gee Creek discharge point. Therefore, Lake River, Salmon Creek, and Mill Creek are all

considered to be tributaries of the Lower Columbia River and contain listed and resident fish species. Critical habitat is designated for the Lower Columbia Chum salmon in lower reaches of Salmon Creek. Within the study area there is documented fish use of Mill Creek. No known barriers to fish passage exist on Mill Creek within the project vicinity.

The study area also includes an off-site parcel approximately six miles south of SR 502, northeast of the I-205/Padden Parkway intersection between NE 88th Street and NE 99th Street in the City of Vancouver. Referred to as Sunset Oaks, the 35-acre undeveloped site would be used as a mitigation site for adverse effects to wetlands within the primary study area along the SR 502 Corridor. Sunset Oaks is in the Salmon Creek Subbasin (WRIA #28) and drains to Salmon Creek via Curtin Creek. Curtin Creek discharges into Salmon Creek upstream of the Mill Creek – Salmon Creek confluence.

The list of baseline documentation used for this analysis is presented in Appendix A. The Draft Preliminary Hydrology Analysis and the *WSDOT Quantitative Procedures for Surface Water Impact Assessments* were the most pertinent data sets and reports for the analysis of water quality effects for this project. These two reports provide the basis for calculating the loading of transportation-related pollutants onto the water bodies and quantify the amount of new pollutant-generating impervious surface (PGIS) and net new PGIS for the project.

2.1.2 Relevant Rules and Regulations

The analysis of potential effects and benefits related to stormwater runoff is necessary to complete Endangered Species Act (ESA) and Essential Fish Habitat (EFH) consultation. The Preliminary Hydrology Analysis Report evaluates the stormwater quality and quantity management for the project. The Preliminary Hydrology Analysis Report does not intend to address each of the nine minimum requirements in the *2006 WSDOT Highway Runoff Manual (HRM)* or fulfill the requirements for a Hydraulics Report as defined in WSDOT's Hydraulics Manual, which are to be completed as part of the final design process.

In 1990, the Washington State Legislature passed the Growth Management Act (GMA) to provide a framework for efficient local planning to manage statewide growth at the local level and to maintain the state's quality of life. The act was passed in response to the legislature's recognition that uncoordinated and unplanned growth posed a threat to the environment, economic development, health, and safety of state residents. In most years since 1990, the Washington State legislature has readopted the GMA.

Clark County has adopted a comprehensive plan that meets the mandates of the GMA. This plan is entitled the *Clark County Comprehensive Plan 2004-2024*. The City of Battle Ground and City of Vancouver have likewise adopted comprehensive plans in accordance with the GMA.

According to the *Clark County Comprehensive Plan 2004-2024*, much of the corridor is Rural-5 designated. A sizeable agriculture zone is located on the northwestern edge of the study area, and is mostly within an industrial reserve overlay zone. Other smaller areas of agricultural zones are found east of NE 72nd Avenue, to the south of SR 502. Centered on the Dollars Corner intersection at NE 72nd Avenue and SR 502 is an area designated as Rural Commercial.

The Lower Columbia Fish Recovery Board has developed the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan for Washington Lower Columbia River salmon and steelhead. The plan stipulates that WSDOT must ensure compliance with environmental laws and statutes when designing and executing transportation projects. This project would be designed and constructed in compliance with environmental laws and statutes; therefore it is consistent with the plan.

There is no combined sewer system in the study area. Runoff in the study area drains to adjacent uplands, wetlands, and streams that eventually discharge to the major surface water bodies identified in Section 4.1.

In July 2006 the United States EPA designated an area within Clark County, which includes the SR 502 Corridor project area, as a Sole Source Aquifer; called the Troutdale Aquifer System. The boundaries of the Troutdale Aquifer System include the Columbia River to the south and west, the North Fork of the Lewis River from its confluence with the Columbia River to the north and Cedar Creek to the east. The Sole Source Aquifer Program is authorized by the Safe Drinking Water Act of 1974 (Safe Drinking Water Act, Public Law 93-523 42 U.S.C. 300 et.seq). Once an area has been designated as a Sole Source Aquifer no commitment for Federal financial assistance may be provided for a project which may contaminate the aquifer through a recharge zone.

Subtitle 40.4 of the Clark County Code addresses Critical Areas and Shorelines. Critical Areas potentially applicable to this Discipline Report include Critical Aquifer Recharge Areas (Chapter 40.410), Flood Hazard Areas (Chapter 40.420), and Shoreline Overlay District (Chapter 40.460).

The Critical Aquifer Recharge Areas chapter is intended to protect public health, safety, and welfare by preventing degradation, and where possible, enhance the quality and quantity of groundwater which will be, or might likely be, used in the future for drinking water or business purposes. This will be accomplished by limiting potential contaminants within designated critical aquifer recharge areas (CARAs). Groundwater protection areas are present within the study area.

The Flood Hazard Areas chapter is intended to protect the public health and regulate the construction and development within flood hazard areas. Mapped floodways and floodway fringe areas are present within the study area and are crossed by the existing SR 502 alignment.

The purpose of the Shoreline Overlay District chapter is to implement the policies and procedures set forth by the Shoreline Management Act of 1971. Although segments of Gee Creek, East Fork Lewis River, and Mill Creek are designated as streams and rivers constituting shorelines of the state (WAC 173-18-100), those segments are outside of the study area. Consequently, a Shoreline Development Permit is not required for this project. In addition, Curtin Creek is not designated as a stream or river constituting shorelines of the state.

A Total Maximum Daily Load water cleanup plan has been implemented for bacteria and turbidity in the Salmon Creek Watershed (Washington State Department of Ecology (Ecology), 2001 & 2005a). In addition, the East Fork Lewis River was selected for a Total Maximum Daily Load study in late 2004. A Quality Assurance Project Plan for the study was completed in 2005 (Ecology, 2005b). Field data collection occurred in 2005 and 2006. Data analysis and modeling

are underway through the first half of 2009. Ecology will complete the study report at some unspecified time in the future (Ecology, 2007a).

Gee Creek is identified as a water-quality-impaired water body (Section 303(d) of the Clean Water Act) by Ecology. Gee Creek has two locations downstream of the study area and west of I-5 that are 303(d)-listed for fecal coliform. The two tributaries of the East Fork Lewis River that drain portions of the northern side of SR 502 project in the central part (i.e. unnamed and Mill Creek North) are not listed as water quality impaired. However, portions of the East Fork Lewis River are 303(d) listed for fecal coliform both upstream and downstream of the mouths of the two tributaries. In addition, the East Fork Lewis River is 303(d) listed for temperature upstream of the mouths of the two tributaries.

Although Mill Creek is not identified as water-quality impaired, portions of Curtin Creek, Weaver Creek and Salmon Creek upstream of the confluence of Mill Creek and Salmon Creek are 303(d) listed for pH and dissolved oxygen. Downstream of the Salmon Creek/Mill Creek confluence a stretch of Salmon Creek west of I-5 is 303(d) listed for dissolved oxygen, pH and temperature.

The Limiting Factors Analysis for Washington State ranked WIRAs #27 and #28 as "poor" with respect to overall salmon habitat condition (Smith, 2005). Mill Creek within WIRAs #27 and #28 was classified as "poor" across all habitat limiting factors. Gee Creek in WIRA #27 was classified as "poor" across most habitat limiting factors. The East Fork of the Lewis River in WIRA #27 was classified as "poor" across most habitat limiting factors.

There is no Habitat Conservation Plan identified for the project area. Clark County does have a Habitat Conservation Ordinance (Chapter 40.400) that defines riparian habitat buffers for streams in Clark County. Additional information regarding riparian habitat buffers is presented in the project's Biological Assessment.

A Biological Assessment is being prepared for this project and it is anticipated to be submitted to the regulatory agencies for review in September 2008. The Biological Assessment will undergo formal consultation with the US National Marine Fisheries Service (NMFS) primarily due to in-water work and potential fish handling associated with this project. ESA consultation with the US Fish and Wildlife Service (USFWS) will be informal.

Close coordination occurred between the discipline report authors and the hydraulic design team to identify effects on the surface water bodies in the study area due to roadway widening and the need to perform stormwater management for runoff generated by the new impervious surfaces.

2.2 Groundwater

Well logs for groundwater wells and geotechnical boreholes in the study area were obtained from Ecology and reviewed to assess the affected environment for groundwater resources. Clark County records were reviewed to identify any groundwater protection areas in the study area. The SR 502 Corridor Project's *Final Hazardous Materials ISA-Level Discipline Report* (Parsons Brinckerhoff, 2008b) was reviewed to identify potential sites that could affect groundwater if disturbed.

2.3 Floodplain

2.3.1 FEMA Studies

The Federal Emergency Management Agency (FEMA) has designated 100- and 500-year floodplains in addition to a floodway for Mill Creek within the project vicinity. The currently effective FEMA Flood Insurance Study (FIS) for Clark County, Washington (Unincorporated Areas) is dated July 19, 2000. The study area is shown on two Clark County Flood Insurance Rate Maps (FIRM), panels 5300240188B and 5300240189B, both dated August 2, 1982. The FIRM panels are included in Appendix B of this Discipline Report. While the FIS is dated July 19, 2000, the hydrologic and hydraulic analyses of Mill Creek in the FIS have not been revised since their completion in November 1979.

The FEMA Flood Boundary and Floodway (Floodway) Map showing the adopted floodway for Mill Creek is panel 5300240188, dated August 2, 1982. While Mill Creek crosses SR 502 (NE 219th Street) three times in the project vicinity, the crossing approximately 500 feet east of NE 72nd Avenue is the only one containing a mapped floodway.

The study area encompasses a portion of SR 502 in Clark County, Washington. The project corridor extends along SR 502 from NE 15th Avenue to NE 102nd Avenue. In the western portion of the project corridor, surface water bodies include unnamed tributaries to Gee Creek, and two tributaries of the East Fork Lewis River drain the north side of SR 502 in the central portion of the project. Mill Creek, a tributary to Salmon Creek, is the surface water body within the eastern and central portion of the study area. However, Mill Creek is the only waterway within the project corridor with mapped floodplains and adopted floodways.

3.0 Affected Environment

This section describes the affected environment, or existing conditions, within the study area.

3.1 Surface Water

3.1.1 Natural Framework to Surface Water

Geologic Setting

Based upon a description of the geology of Washington provided by the Washington State Department of Natural Resources (DNR), Division of Geology and Earth Resources, the study area is in the Portland Basin, which marks the northern terminus of the Willamette Lowland of Oregon (DNR 2007b). In Washington, the northern portion of the Portland Basin is characterized by the low topographic relief of western Clark County. Starting at the basement of the basin is Columbia River basalt, which lies more than 1,000 feet below the surface. Subsequently the basin was filled by sediments of the ancestral Columbia River (Troutdale Formation), Boring Lava volcanism, and lastly, the glacial Lake Missoula catastrophic floods. The waters from the floods ponded in the Portland Basin; backwaters caused the deposition of well-sorted sand, clay, and gravel.

Soils

The study area is in the Columbia and Lewis River valleys and their tributaries in the western and southern parts of Clark County. The *Soil Survey of Clark County, Washington,* prepared by the United States Department of Agriculture, Soil Conservation Service, cites the study area's

soil of two associations: the *Hillsboro-Gee-Odne* soil association (western portion of the study area) and the *Hillsboro-Dollar-Cove* association (central and eastern portion of the study area) (SCS 1972). The Sunset Oaks mitigation site is also composed of soils of the *Hillsboro-Dollar-Cove* soil association.

The *Hillsboro-Gee-Odne* soil association is described as nearly level to steep soils on terraces of the Columbia and Lewis Rivers and their tributaries and where terraces are dissected by steep-sided narrow drainage ways. In the study area, the *Hillsboro-Gee-Odne* soil association is well-drained, medium-textured soils, except near Gee Creek where the soil is poorly drained. This association occupies about 14 percent of the county.

The *Hillsboro-Dollar-Cove* soil association, described as nearly level to steep, undulating terraces of the Columbia River and its tributaries in the central and eastern parts of Clark County. In the study area, the *Hillsboro-Dollar-Cove* association is nearly level and poorly drained. This association occupies about 12 percent of the county.

These soil associations within the study area are not prone to severe soil erosion or severe slope instability.

Climate

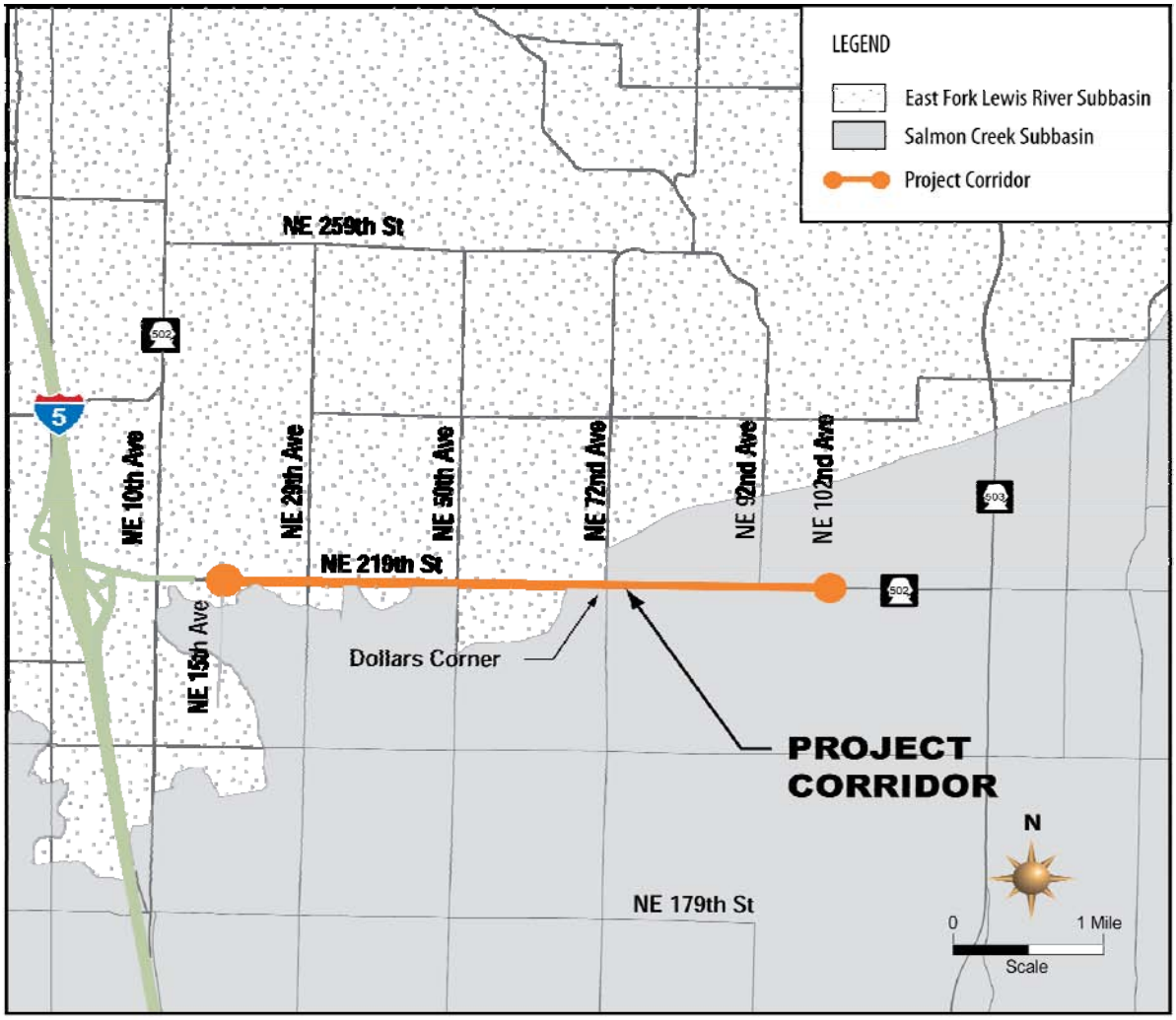
The climate in the study area is characterized by mild, wet winters and warm summers. Maritime air masses generally dominate the vicinity during the year. Mean monthly high temperatures range from 45°F to 79°F, while mean monthly low temperatures range from 32°F to 50°F. The annual precipitation is nearly 52 inches, with 73 percent of this total occurring between October and March. On average, less than 6 inches of snowfall occur annually (NOAA 2007).

3.1.2 Surface Water Resources

Basins, Subbasins, and Project Boundaries

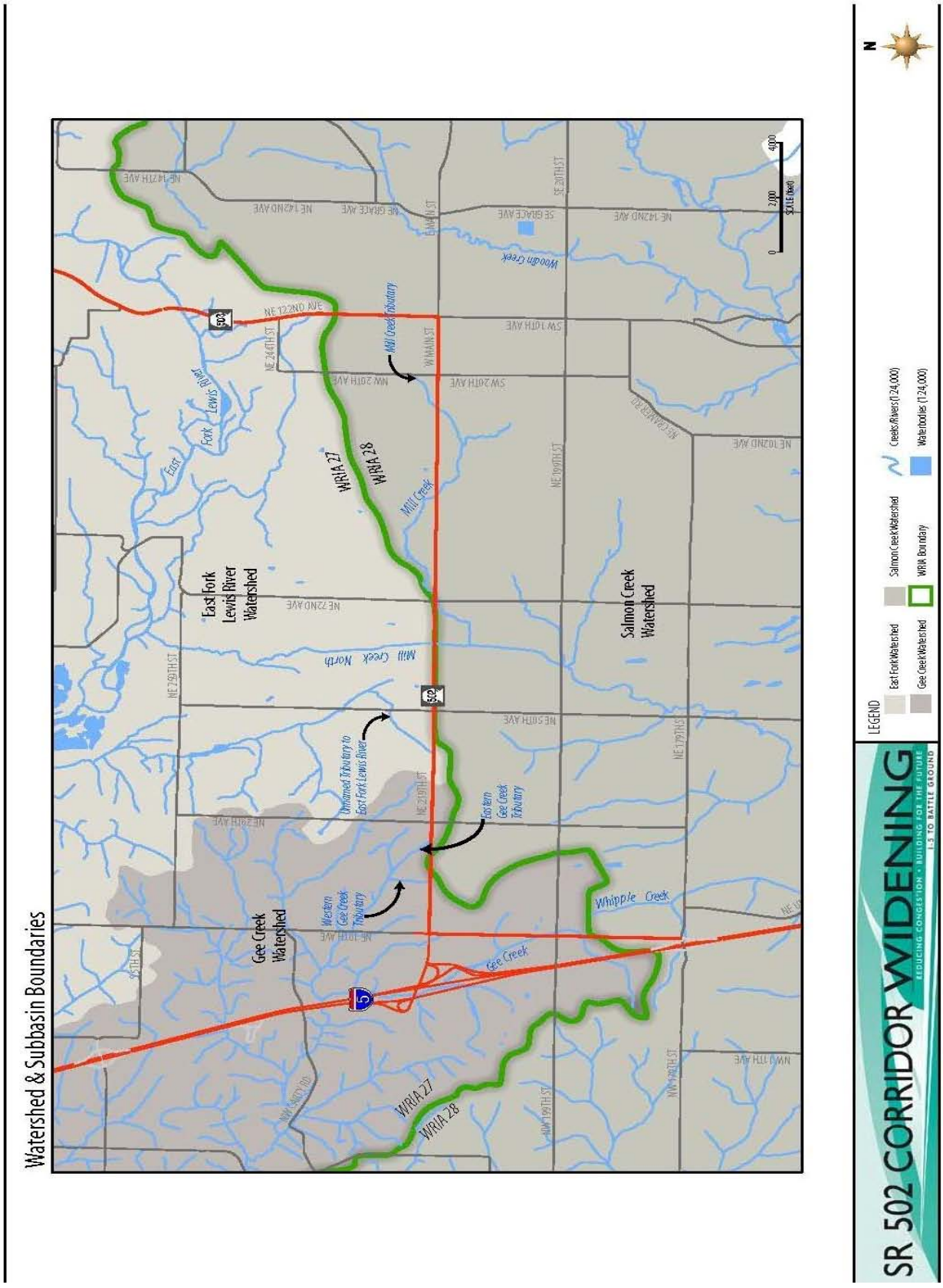
The study area straddles the East Fork Lewis River Subbasin (WRIA #27) and the Salmon Creek Subbasin (WRIA #28) (Ecology 2007c) (Exhibit 1). Unnamed tributaries to Gee Creek are the surface water bodies that are within the western portion of the study area and associated with the East Fork Lewis River Subbasin.

Exhibit 1.Subbasins in the Study Area



There are two tributaries of the East Fork Lewis River that drain the north side of SR 502 in the central portion of the study area (Exhibit 2). Of the two tributaries to the East Fork Lewis River, the western one is unnamed while the eastern one is known as Mill Creek North. The East Fork Lewis River discharges to the mainstem of the Lewis River west of La Center, Washington. The Lewis River discharges to the Columbia River. As such, the East Fork Lewis River is considered a tributary of the Lower Columbia River and contains listed and resident fish species. Within the study area there is a potential for anadromous fish use of Mill Creek North and other unnamed tributaries to the East Fork Lewis River. However, there are fish barriers to the north (downstream of the study area) on the unnamed tributaries of the East Fork Lewis River.

Exhibit 2. Watershed and Subbasin Boundaries in the Study Area



Gee Creek discharges to the Columbia River immediately upstream of the confluence of the Lewis and Columbia Rivers. As such, Gee Creek is considered a tributary of the Lower Columbia River and contains listed and resident fish species. Within the study area there is no documented anadromous fish use of the unnamed tributaries to Gee Creek due to barriers at numerous farm ponds.

Mill Creek, a tributary to Salmon Creek, is the surface water body within the eastern and central portion of the study area and is associated with the Salmon Creek Subbasin south of the project site. Mill Creek discharges into Salmon Creek, which in turn discharges into Lake River within the Ridgefield National Wildlife Refuge. Lake River joins the Columbia River upstream (south) of the Gee Creek discharge point. Therefore, Lake River, Salmon Creek, and Mill Creek are all considered to be tributaries of the Lower Columbia River and contain listed and resident fish species. Within the study area there is documented anadromous fish use of Mill Creek. No known barriers to fish passage exist on Mill Creek within the project vicinity.

Curtin Creek, within the Sunset Oaks mitigation site, is a tributary to Salmon Creek and is considered a tributary of the Lower Columbia River.

Mill Creek, Mill Creek North and Curtin Creek are stream type "F" according to the DNR Forest Practices Application Review System maps (DNR 2007a). All other unnamed tributaries to Gee Creek and East Fork Lewis River are designated stream type "N". Stream type "F" is defined as a fish use stream. Stream type "N" is defined as a non-fish habitat stream.

The beneficial uses for waterbodies in the study area include: domestic, stock watering, industrial, commercial, agricultural, irrigation, fish and wildlife maintenance and enhancement, recreational preservation of environmental and aesthetic values, and all other uses

The watershed sizes for Gee Creek, East Fork Lewis River, Mill Creek, and Salmon Creek are 18.8 square miles, 212 square miles, 12 square miles and 89 square miles, respectively. With respect to the watershed sizes, the ratios of the project threshold discharge areas (TDAs) to the respective watershed sizes are 0.002, 0.0002, and 0.007 for the Gee Creek, East Fork Lewis River and Mill Creeks, respectively.

FEMA has designated 100- and 500-year floodplains in addition to a floodway for Mill Creek within the project vicinity. For Gee Creek tributaries as well as the two tributaries of the East Fork Lewis River in the project vicinity, there are no designated floodplains. FEMA has also designated a 100-year floodplain for Curtin Creek at the wetland mitigation site.

Clark County has monitored flow data in Gee Creek (Clark County, 2007) and Mill Creek (Hutton, 2007) beginning in 2003. Although there is no flow data for the unnamed tributary of the East Fork Lewis River and only one flow measurement for Mill Creek North in July of 2005 (Ecology, 2007b), there is flow data available for the river itself from 1930 through the present at USGS Station 14222500 near Heisson, Washington, at River Mile 20.2, corresponding to a drainage area of 125 square miles.

For both streams and the river, stream flow patterns closely follow precipitation patterns. Stream flow tends to be heaviest from December through April, which accounts for 84 percent and 85 percent of the total annual runoff for Gee Creek and Mill Creek, respectively. The smallest flows

occur from July through September. For Gee Creek and Mill Creek the average flow during water years 2004 through 2006 was 17 cubic feet per second (cfs) and 13 cfs, respectively. During this period, the maximum recorded daily average flows were 360 cfs and 172 cfs, while the minimum recorded daily average flows were 0.27 cfs and 0.14 cfs for Gee Creek and Mill Creek, respectively.

Based on monthly mean discharge statistics between 1930 to the present for the East Fork Lewis River, at the USGS gauge near Heisson, Washington, the heaviest runoff occurs from November through April, which accounts for 82 percent of the total annual runoff. For the same period of record, the maximum and minimum recorded daily averaged values are 21,000 cfs (associated with the 1996 flood) and 30 cfs.

Water quality data have been collected on Gee Creek, the East Fork Lewis River, Mill Creek and Salmon Creek (Ecology, 2007b). Water quality data were collected from Gee Creek between October 1994 and September 1995 at station 27F070, located in Ridgefield, Washington. Water quality data are collected near the mouth of Mill Creek at Salmon Creek Avenue, Station Number 28J070, on a monthly basis from October 2006 through the present. Sampled parameters for Gee Creek and Mill Creek include ammonia, barometric pressure, conductivity, dissolved oxygen, fecal coliform, nitrite-nitrate, ortho-phosphate, pH, phosphorus, temperature, total persulfate nitrogen, total suspended solids and turbidity. Station 28D070 on Salmon Creek east of I-5 was monitored twice a month from October 1972 through September 1973 for most of the parameters noted above for Gee Creek and Mill Creek. Between I-5 and Lake River Station, SALCSRB on Salmon Creek was monitored every other month from April to October 1993 for pesticides, with well over a hundred constituents.

Several water quality monitoring stations are located along the East Fork Lewis River, from the mouths of the tributaries that reach the study area to the confluence with the mainstem of the Lewis River. At these stations the measured parameters include fecal coliform and temperature, depending on the station. The station near Dollar Corner on the East Fork Lewis River is a long term station (Number 27D090) with monthly data for all of the same constituents noted above for Gee Creek and Mill Creek, in addition to alkalinity and hardness as $CaCO_3$, dating from October 1976 to the present. In addition, intensive temperature monitoring using a data logger for both air and water were collected from July through September, beginning in 2001 through the present.

The health of the three watersheds with respect to water quality is summarized by Clark County (2004). Downstream of Carty Road, Gee Creek is listed as being in poor condition, while upstream of this location, including in the vicinity of I-5 Gee Creek rest area, Gee Creek and some of its tributaries are listed as being in poor condition, although this is qualified as "probable". Potential sources that may be contributing to the poor health include runoff from urban, developed, and agricultural areas as well as I-5. Potential bacterial contamination from agricultural practices was noted.

The East Fork Lewis River is in good overall condition, although the lower reach is affected by elevated temperature and bacterial contamination. In some of the lower tributaries of the East Fork Lewis River, bacterial contamination and a reduced diversity of stream life are noted.

Although no stream condition is noted for the unnamed tributary, Mill Creek North is shown as being in poor condition, although this assessment is qualified as "probable".

The lower reaches of Mill Creek downstream of NE 199th Street are in fair condition based on monitoring at its mouth. The lower reaches of Salmon Creek downstream of the City of Battle Ground are in poor health, due to bacteria and turbidity which are the two targeted parameters of the Total Maximum Daily Load (TMDL) Study (Ecology, 2001).

Channel Characteristics

Channel characteristics above and below each existing stream crossing is presented in Exhibit 3.

Exhibit 3. Channel Characteristics at Stream Crossings / Existing Conditions

Waterbody	Location	Existing Culvert Type	Existing Culvert Size	Channel and Bank Condition at Crossing
Mill Creek	On NE 72nd Avenue	Concrete Arch	29 feet in diameter by 43 feet in length	The portion of Mill Creek that flows through the action area is a shallow incised channel, which has been largely isolated from its floodplain, except in the vicinity of its confluence with Mill Creek North, where a floodplain wetland exists. Substrate within Mill Creek consists of some adequate sized particles (gravel and cobble) for steelhead spawning, with a moderate amount of embeddedness. Runoff from agricultural and urban development within the action area has increased the delivery of fine-grained sediments to the Creek, but habitat is still likely adequate for steelhead spawning.
Mill Creek	SR 502 – MP 5.2	Concrete Box Culvert (Two Cells)	10 feet in width by 6 feet in height by 55 feet in length	Channel conditions are as described above. East of Dollars Corner, Mill Creek flows through a narrow band of forested riparian vegetation, which provides some shade and also provides a source of large woody debris (LWD). Elsewhere riparian vegetation is largely emergent or lacking entirely.
Mill Creek	SR 502 – MP 5.95	Corrugated Steel Pipe (Two)	6 feet diameter by 73 feet in length and 6 feet in diameter by 81 feet in length	Channel conditions are as described above. The riparian buffer is primarily upland grassland north of SR 502, and a mosaic of upland and wetland habitat to the south of SR 502.
Mill Creek North	SR 502 – MP 4.6	Concrete Box Culvert	9 feet in width by 4.5 feet in height by 48 feet in length	Immediately north and south of SR 502, Mill Creek North exists as an artificially constructed channel that is hydrologically connected to a larger floodplain. Substrate within the channel is largely fine grained and unsuitable for spawning. Downstream (north) of the action area, the channel is better defined, with some natural sinuosity, and substrate is of better quality for spawning. Riparian vegetation along Mill Creek North within the action area consists largely of emergent vegetation, predominantly reed canarygrass. In the large wetland floodplain that is associated with Mill Creek North adjacent to SR 502, emergent vegetation also consists of pasture grasses and native emergent vegetation. Very little tree or shrub cover is present, and LWD is also largely lacking.

Water Quality

Gee Creek is identified as a water-quality-impaired water body (Section 303(d) of the Clean Water Act) by Ecology. Gee Creek has two locations downstream of the study area and west of I-5 that are 303(d)-listed for fecal coliform. The two tributaries of the East Fork Lewis River that

drain portions of the northern side of SR 502 in the central portion (i.e. unnamed and Mill Creek North) are not listed as water quality impaired. However, portions of the East Fork Lewis River are 303(d) listed for fecal coliform both upstream and downstream of the mouths of the two tributaries. In addition, the East Fork Lewis River is 303(d) listed for temperature upstream of the mouths of the two tributaries.

Mill Creek is not identified as a water-quality-impaired water body. Salmon Creek downstream of its confluence with Mill Creek is identified as a water-quality-impaired water body for temperature, pH, and dissolved oxygen. Curtin Creek just upstream of its discharge point into Salmon Creek is water-quality impaired for pH and dissolved oxygen.

A TMDL water cleanup plan has been implemented for bacteria and turbidity in the Salmon Creek Watershed (Ecology, 2001 & 2005a). In addition, the East Fork Lewis River was selected for a TMDL study in late 2004. A Quality Assurance Project Plan for the study was completed in 2005 (WA Ecology, 2005b). Field data collection occurred in 2005 and 2006. Data analysis and modeling are underway through the first half of 2009. Ecology will complete the study report at some unspecified time in the future (WA Ecology, 2007a).

Other than the stream health related effects discussed above, which are primarily due to non-point sources for temperature, turbidity, and bacteria, there are no other known water quality problems in either of the three drainages within the vicinity of the project.

Mill Creek crosses SR 502 three times (Exhibit 4). In addition, the identified threshold discharge areas (TDAs) empty into several unnamed tributaries of Gee Creek, an unnamed tributary of the East Fork Lewis River, Mill Creek North and Mill Creek. As the slopes in the vicinity of the stream crossings are quite low, erosion is not anticipated to cause effects. The potential for effects are associated with water quality due to stormwater runoff and short term effects associated with construction.

Existing Drainage Pathways

Stormwater runoff from the existing project corridor is conveyed to the receiving water bodies through a culvert and ditch system. Inlets, culverts, and ditches convey stormwater runoff from the existing pavement area to the wetland/stream system. Currently there is no active treatment of stormwater runoff from SR 502. Some passive treatment is occurring as stormwater passes through the vegetated ditches and wetlands; however, there is no engineered diversion of stormwater for infiltration and treatment that would prevent it from reaching the natural watercourses or wetlands.

The existing project drainage area is divided into separate TDAs to serve as the basis of comparison between the existing and proposed conditions. A TDA is defined as an on-site area draining to a single natural or manmade discharge location or multiple or manmade discharge locations that combine within one-quarter mile downstream (as determined by the shortest flow path).

The TDAs for this project were delineated based upon existing contours, culvert as-built information, and survey data from WSDOT, during 2006 and 2007, as baseline data was collected for the design of this project. The existing drainage area was divided into eight separate

TDAs as shown in Exhibit 4. A description of the characteristics of each of the TDAs is presented in Exhibit 5. For the purposes of analyzing effects associated with this project, all impervious surfaces in the study area are considered to be PGISs. The total amount of existing PGIS in the study area is approximately 23 acres. This represents approximately 20 percent of the total surface area (impervious and pervious) within the study area.

Wetlands

A *Wetland Delineation Discipline Report* was prepared for this project; this summary presents the investigation and analysis prepared in that discipline report. WSDOT wetland specialists delineated 74 wetlands within the proposed project corridor. Spatially, wetlands of various categories and Cowardin classes are distributed relatively equally on both sides of SR 502, although the north side contains two Category I wetlands, nine Category II wetlands, 13 Category III wetlands, and nine Category IV wetlands, while the south side of SR 502 contains one Category I wetland, two Category II wetlands, 15 Category III wetlands, and 23 Category IV wetlands according to the *Washington State Wetland Rating System for Western Washington* (Hruby 2004). Some of the wetlands are hydrologically connected and were rated as one large wetland complex. Many of the wetlands extend beyond the project boundaries and are components of larger wetland complexes.

The wetlands consist of depressional and riverine hydrogeomorphical classes, and numerous Cowardin classes are present: including; palustrine forested (PFO); palustrine emergent (PEM); and palustrine scrub-shrub (PSS). Most riverine wetlands are associated with seasonal headwater swales and not perennial streams. One large Category I wetland received regular hydrologic inputs from Mill Creek during fall and winter months. The biological, chemical, and physical functions provided by these wetlands range from very low to high, with the higher functioning wetlands more prevalent to the north of SR 502.

Fisheries

A separate *Final Biology Discipline Report* (Parsons Brinckerhoff, 2008a) has been prepared for this project; this summary presents the investigation and analysis prepared in that discipline report. During the studies conducted for wetlands, ecologists examined and evaluated fish habitat within the study area. Stream characteristics were determined for Mill Creek and potential barriers to fish passage were evaluated. In addition, ecologists consulted with resource agencies and databases regarding documentation of federal- and state-listed, or candidates for listing, in the study area.

Mill Creek and Mill Creek North are presumed habitat for chum salmon (*Oncorhynchus keta*) and Chinook salmon (*O. tshawytscha*), and documented habitat for winter steelhead (*O. mykiss*) (presumed for summer steelhead), and coho salmon (*O. kisutch*). Based on discussions with Washington Department of Fish and Wildlife (WDFW) and the Clark County habitat biologist, Mill Creek and Mill Creek North provide suitable over-wintering habitat for coho salmon and suitable spawning habitat for sea-run/resident cutthroat trout and steelhead.

WDFW staff indicates bull trout (*Salvelinus confluentus*) do not occur in Mill Creek or Mill Creek North. Anadromous fish do not occur in the Gee Creek tributaries in the study area due to barriers at numerous farm ponds. The salmonid and steelhead fishery resources are protected under the federal Endangered Species Act.

Exhibit 4. Threshold Discharge Areas in the Study Area

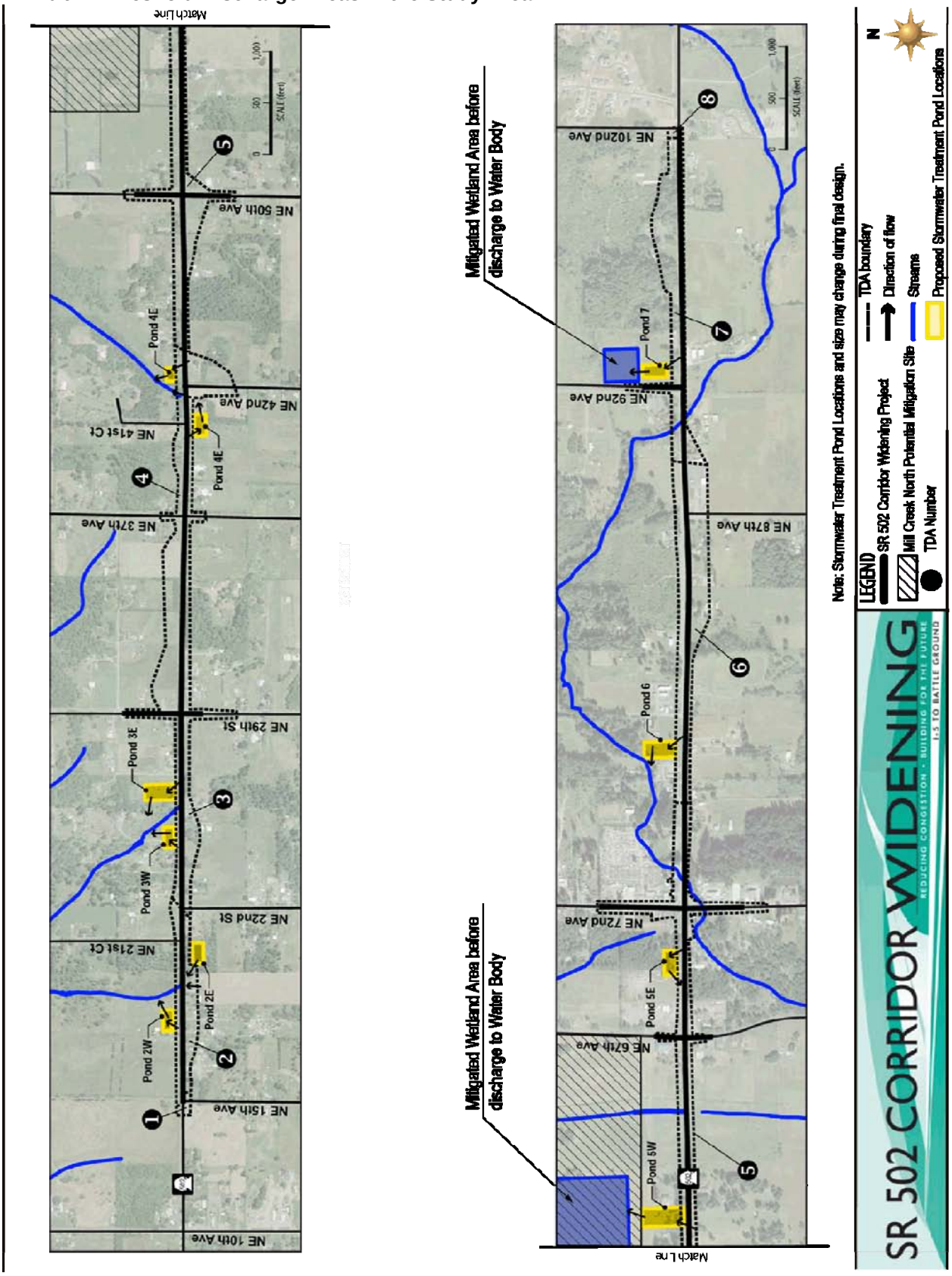


Exhibit 5. Threshold Discharge Areas (TDAs) Characteristics / Existing Conditions

TDA No.	Size of TDA (acres)	Amount of Existing Pollution Generating Impervious Surface (PGIS) (acres)	Comments
1	0.54	0.32	TDA No. 1 will be treated by an SR 502 Interchange pond and then flow to a tributary of Gee Creek that is not fish bearing. This discharge undergoes additional dilution by the time it reaches the anadromous fish bearing area of the Gee Creek drainage basin.
2	8.40	1.79	TDA No. 2 discharges to a tributary of Gee Creek that is not fish bearing. Private ponds stop fish passage due to damming of the tributary. This discharge undergoes additional dilution by the time it reaches the anadromous fish bearing area of the Gee Creek drainage basin.
3	20.92	3.28	TDA No. 3 discharges to a tributary of Gee Creek that is not fish bearing. Private ponds stop fish passage due to damming of the tributary. This discharge undergoes additional dilution by the time it reaches the anadromous fish bearing area of the Gee Creek drainage basin.
4	12.06	1.80	TDA No. 4 discharges to an unnamed tributary of the East Fork Lewis River that is not fish bearing. However, this tributary is fish bearing in close proximity downstream of the TDA No. 4 discharge location.
5	35.41	8.74	One half of TDA No. 5 discharges to Mill Creek North while the other half discharges to Mill Creek. The project proposes to avoid inter-basin transfer and associated environmental effects due to such alternations in flow. Mill Creek drains to the Salmon Creek Watershed while Mill Creek North drains to the East Fork Lewis River watershed. Anecdotal evidence suggests that Mill Creek North only drains to the East Fork Lewis River during the winter months. Both streams are fish bearing. Only Mill Creek North is considered critical habitat for steelhead.
6	18.68	3.20	TDA No. 6 discharges to Mill Creek east of Dollars Corner on the north side of SR 502. Mill Creek is fish bearing at this location. Discharge from TDA No. 6 will not transfer into TDA No. 5 where it is a closed system from NE 67th Avenue to NE 82nd Avenue.
7	16.34	3.39	TDA No. 7 discharges to Mill Creek east of the Battle Ground Williams Northwest Pipeline Compressor Station at one of the Mill Creek culverts that cross SR 502. Mill Creek is fish bearing at this location.
8	0.33	0.09	TDA No. 8 discharges to the City of Battle Ground MS4 system then to the City of Battle Ground stormwater detention facility.

3.2 Groundwater

The Puget-Willamette Trough aquifer system underlies an elongated basin that extends southward from near the Canadian border in Washington to central Oregon. In the central area of the basin, which includes the study area, natural discharge from unconsolidated deposits and Miocene basaltic-rock aquifers flows mostly toward the Columbia River. Recharging of groundwater primarily occurs by direct infiltration and seepage from precipitation, surface waters, and surface runoff.

In the central area of the basin, which includes the study area, natural discharge from unconsolidated-deposit and Miocene basaltic-rock aquifers flows mostly toward the Columbia River. In this area, large volumes of water are withdrawn by wells in and near the Columbia River Valley. A review of the well drilling logs for private land owners along the SR 502 Corridor indicates that domestic-use groundwater is drawn from a depth of 41 to 88 feet below level ground in a layer of cemented and partially-cemented gravel. The shallower depths to groundwater occur between NE 50th and NE 72nd Avenues. Static water levels range from a depth of 23 to 88 feet below level ground, with the shallower depths also occurring between NE 50th and NE 72nd Avenues. There is also a City of Battle Ground public water supply well at the eastern edge of the study area. This well draws water from a depth of 272 to 379 feet below level ground and was completed in 2004 to a total depth of 410 feet below level ground.

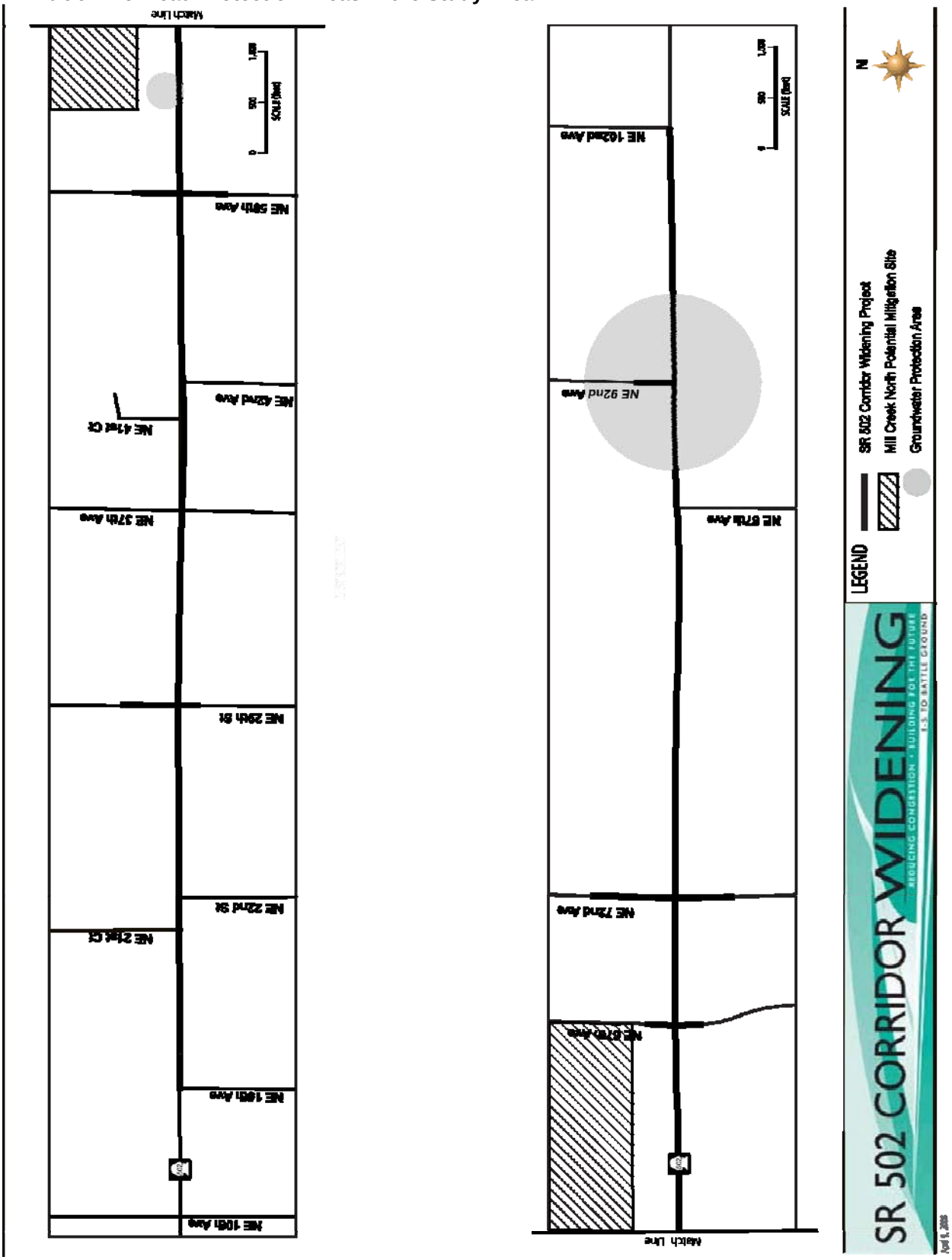
A review of geotechnical borings in the study area shows that shallow groundwater is first encountered at about 6 feet below level ground and that soils in the vadose zone (above the groundwater and closer to level ground surface) are characterized as moist to very wet. WSDOT intends to install piezometers to measure near-surface groundwater elevation within the study area; data on near-surface groundwater elevations is not available for inclusion in this discipline report.

Clark County GIS identifies two groundwater protection areas within the study area. The first one is centered on SR 502 between NE 50th and NE 72nd Avenues at the western edge of the floodplain (see Section 3.3.5) (Exhibit 6). The second groundwater protection area is also centered on SR 502 at the Mill Creek crossing near NE 92nd Avenue. Both of these groundwater protection areas are identified as Category 1 recharge areas.

The Clark County Comprehensive Plan has identified an area south of SR 502 that is centered on NE 72nd Avenue as being a wellhead protection area.

Based upon the *Final Hazardous Materials ISA-Level Discipline Report* (Parsons Brinckerhoff, 2008b), ten reasonably predictable hazardous materials sites were identified within 1,000 feet of the SR 502 Corridor Widening study area. The sites of most concern are those that have soil or groundwater contamination located within or adjacent to the study area. Four high potential effect sites have documented soil contamination and are located within or near the project construction area, near the intersection of SR 502 and NE 72nd Avenue. Three medium potential effects sites have documented soil and groundwater contamination and are located within 1,000 feet of the study area. The remaining three sites are considered low potential effect due to the presence of hazardous materials without documented environmental releases; however, two of the three sites are located adjacent to the study area with frontage acquisitions planned as part of this project.

Exhibit 6. Wellhead Protection Areas in the Study Area



3.3 Floodplain

3.3.1 Flood Hazard

The primary source of flooding along the project reach of SR 502 is Mill Creek. Mill Creek near its approach to Dollars Corner (the intersection with SR 502 and NE 72nd Avenue) has undergone a detailed study with base flood elevations and a floodway developed. The detailed mapping of the 100-year floodplain associated with Mill Creek and a Mill Creek tributary immediately west of NE 72nd Avenue continues towards the south past NE 179th Street (Exhibit 7).

The FEMA FIRM panel 5300240188B and Floodway panel 5300240188 map the 100-year floodplain of Mill Creek, extending along approximately 1,200 feet of SR 502 west of NE 67th Avenue (Exhibit 7). The mapped 100-year floodplain area is zoned A1, which indicates that the map boundaries were developed from the results of FEMA's detailed hydrologic and hydraulic computer modeling of Mill Creek. Both the FIRM and Floodway maps also show an area of 100-year floodplain, zoned A, which extends north from the Mill Creek floodplain across SR 502. Zone A represents areas that FEMA approximated as flooding during a 100-year flood but did not perform detailed hydraulic analyses of the area. The ground surrounding SR 502 in the project vicinity predominantly consists of low-lying pastures which are reflected in the FEMA FIRM and Floodway maps.

The majority of the study area is identified on the FEMA FIRM maps as Zone C, which represents areas of minimal flooding, where the average flood depths are less than one foot.

There are no mapped floodplains in the western portion of the study area associated with the unnamed tributaries of Gee Creek or the two tributaries of the East Fork Lewis River.

3.3.2 Channel Stability

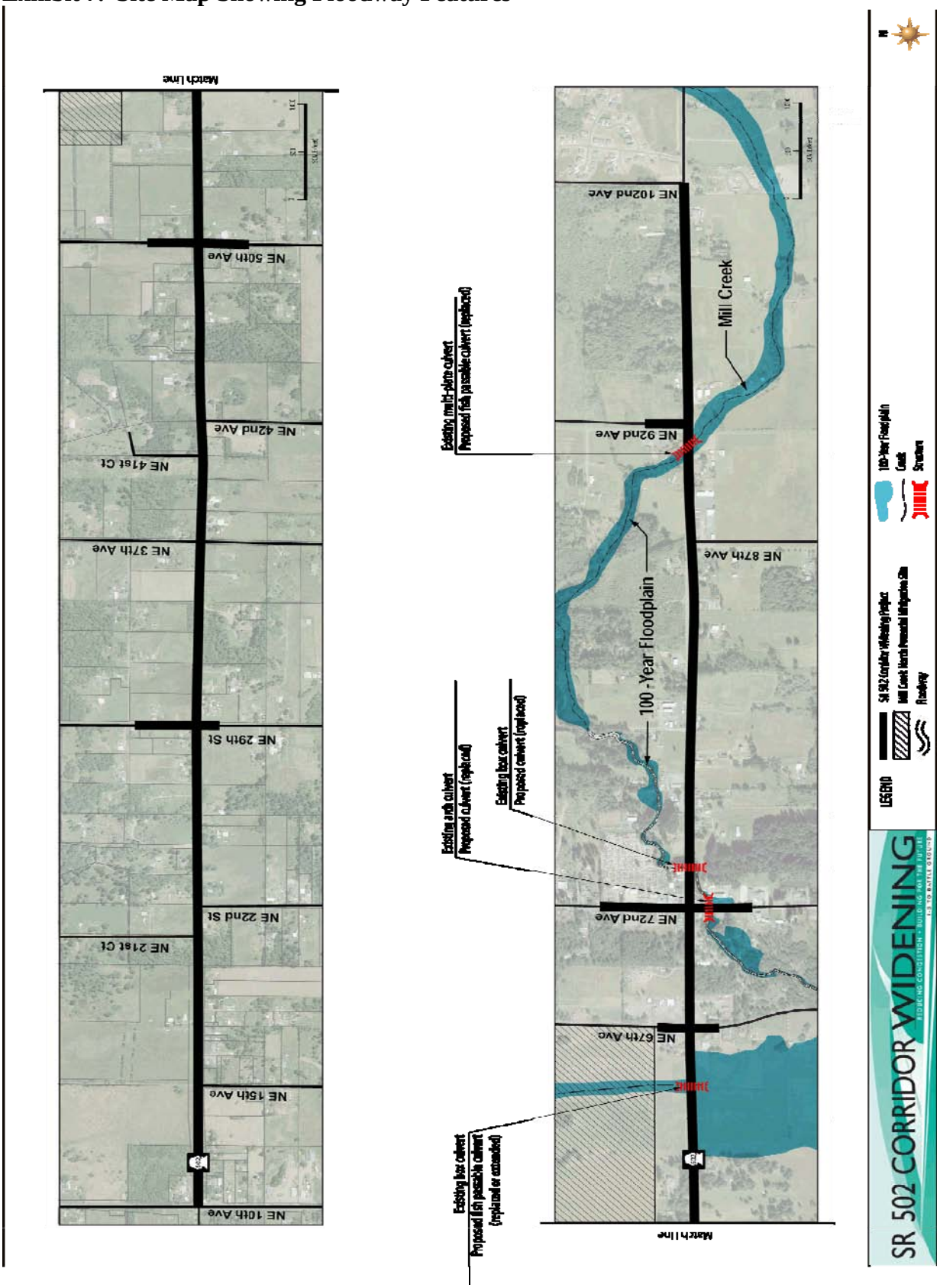
The channel of Mill Creek is not constrained in the project vicinity by levees or substantial bank stabilization projects. As such, the channel has the capacity to migrate within the study area.

Whether or not Mill Creek may avulse in the future in the project vicinity depends upon several factors including, but not limited to, bank stability and cohesion, channel sinuosity, deposition or erosion, water velocities, and bedload. At each of the crossings, site photographs from the fall of 2007 show well-vegetated banks, covered with grasses, brush, and blackberries. While the channel of Mill Creek has some sinuosity, the only crossing with sinuous curves upstream is the culvert under SR 502 just east of NE 72nd Ave. The other three existing structures are located in relatively straight to gently meandering channel reaches.

From the FEMA FIS, the 100-year flood discharge is 585 cfs. Within the project reach, the average 100-year flood velocity varies from 2.0 to 7.6 feet per second (fps). Based on Clark County's monitoring, the observed substrate of Mill Creek is predominantly coarse gravels and cobbles.

Channel avulsion is not typically an instantaneous phenomenon, with some channels taking years, decades or longer to avulse. Prior to avulsion, the channel would likely provide some indications of future movement, such as eroding or slumping banklines, an increase in the

Exhibit 7. Site Map Showing Floodway Features



channel's sinuosity, and changes in the deposition and erosion patterns.

3.3.3 Debris

The channel of Mill Creek contains several sharp bends in the project vicinity, some more than ninety degrees. Abrupt changes in channel directions present opportunities for collection of floating debris; however, no observations of either accumulated debris or channel meander were made to indicate that debris poses a problem on Mill Creek.

The availability of Large Woody Debris (LWD) varies depending upon the reach of Mill Creek under consideration. Upstream of the Mill Creek crossing west of NE 92nd Avenue, the creek's riparian zone predominantly consists of open horse pastures and hayfields with limited rural residential development. Limited trees exist along the banks in the upper reach. Between NE 67th Avenue and NE 92nd Avenue, the agricultural/pasture land use includes some urban residential and commercial development. In this reach, the riparian zone contains a narrow to moderate well forested buffer. Downstream of NE 67th Avenue, Mill Creek's riparian zone reverts to open agricultural land and pastures with limited trees observed.

The 2001 Long-Term Index Site Monitoring Project by Clark County Public Works provided some additional information on LWD in Mill Creek. The index reach for Mill Creek is near the Salmon Creek confluence, approximately 0.25 miles upstream from its mouth, and downstream of the project reach. Within the index reach, the LWD count provided a density of around 145 pieces/kilometer. One factor to consider is that some of the tally was credited to the placement of LWD during stream rehabilitation projects by Washington State University and potentially others in the index reach.

3.3.4 Skew of Crossing

At the Mill Creek crossing just east of NE 72nd Avenue, SR 502 is approximately perpendicular to the crossing, and the concrete box culvert has no skew. In addition, Mill Creek under NE 72nd Avenue just south of SR 502 is also approximately perpendicular to the roadway, and the concrete arch also has no skew. The large diameter steel multiplate culvert under SR 502 west of NE 92nd Avenue has approximately a 45 degree skew to the channel.

3.3.5 Floodplain Limits

As depicted in Exhibit 7, sections of the study area that are proposed to receive fill fall within the 100-year floodplain of Mill Creek. However, no fill is proposed within the floodway of Mill Creek. In Clark County, the floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot (FEMA, NFIP Policy).

The floodplain areas to be filled are primarily open pastures, agricultural land and rural residential development. Within Battle Ground, the floodplain areas also include some urban residential and commercial developments. In the project vicinity, the only encroachment on Mill Creek's floodplain occurs around Dollars Corner and the businesses and residences along the creek in Battle Ground. A large majority of the floodplain is free of encroachment due to its land use as open pastures and fields.

Watershed characteristics of Mill Creek were obtained from Clark County Public Works' 2005 water quality monitoring report, including total impervious area (TIA), forest cover, and road density. From the report, Mill Creek has a TIA of approximately 23 percent. The TIA figure includes roads, buildings and other surfaces that create runoff, including semi-permeable surfaces such as agricultural lands. The report also noted a forest cover of approximately 16 percent from a land cover analysis. An additional measure of urbanization on a waterway is the road density, which the report cited as 6.9 miles of roads per square mile of land.

The creek's channels are typical of other small waterways in the region with a pool-riffle morphology. At the Clark County monitoring site, Mill Creek's gradient was approximated between one and three percent.

As Exhibit 7 shows, the mapped floodplain along SR 502 (NE 219th Street) stays within the channel in places east of NE 67th Avenue. However, just west of NE 67th Avenue, the mapped floodplain of Mill Creek extends over 1,300 feet north of its banks to SR 502.

As a result of construction, fill would be placed within the floodplain of Mill Creek; however, no major fills are proposed due to the relative flatness of the study area. The existing Mill Creek crossings in the study area will be extended or replaced.

Within the study area, the regulatory 100-year flood elevation for Mill Creek is established as follows:

- West end of the project to less than 0.1 miles downstream of NE 67th Avenue – 195.1 feet National Geodetic Vertical Datum (NGVD);
- NE 67th Avenue – 199.5 feet NGVD;
- NE 72nd Avenue – 213.2 feet NGVD;
- NE 219th Street (SR 502) – 215.8 feet NGVD; and
- Half mile upstream of NE 219th Street – 229 feet NGVD (upstream FEMA study limit).

While the proposed floodplain fills would result in the minor loss of some floodplain storage, the design will create compensatory flood storage. Clark County's regulations address no reduction of existing conveyance capacity and no net loss of existing storage capacity during the 100-year flood (Section 40.380 Stormwater and Erosion Control). The proposed project would comply with Clark County's Unified Development Code through the floodplain permit process.

3.3.6 Consistency with Existing Watershed and Floodplain

The existing SR 502 spans Mill Creek at three locations in the project corridor, containing the channel within a structure at each location. The proposed widening of SR 502 would extend or replace the three existing creek crossings such that no reduction in conveyance occurs. The runoff and flows will remain in their basin of origin for the proposed project, maintaining the integrity of the existing floodplain and watershed. In addition, a fourth structure under SR 502 that conveys flow to Mill Creek will also be replaced. No new crossings of Mill Creek or alterations to the creek's channel are proposed.

3.3.7 Current/Proposed Water Resource Projects

No reservoirs or other flow regulation structures are located on Mill Creek, and no proposed water resource projects were identified on Mill Creek.

As no water resource projects were identified, the proposed widening is not anticipated to impact current water resource projects.

3.3.8 Flood History

FEMA's Flood Insurance Study (FIS) indicates that flooding along Mill Creek is similar to other waterways in the area. Flooding typically occurs during the winter by a combination of snowmelt and precipitation, and spring and early summer floods can occur due to heavy rainfall. Over bank flooding is typically minor in the upper reaches of a waterway, and backwater effects produce increased over bank flooding near the confluence with larger waterways.

Mill Creek is a tributary to Salmon Creek, and flooding on Salmon Creek could reasonably provide an indication of flooding on Mill Creek. From the FEMA FIS, the largest recorded flood on Salmon Creek occurred in December 1977, and major floods on Salmon Creek were recorded in January 1954 and December 1964. The floods were attributed with only causing minor damage.

Records from the February 1996 flood event do not indicate Mill Creek flooding or damaging structures. In the project vicinity, Salmon Creek and the East Fork Lewis River both experienced levee failures. Salmon Creek also flooded several residences, some with four feet of water, in addition to washing out private roads and a gravel pit dike.

Anecdotal evidence from a resident of the Dollars Corner area indicates that winter floods over the past few years have typically reached within a foot of overtopping SR 502, but the roadway does not submerge.

3.3.9 Existing Structures

Three crossings of Mill Creek would be affected during the proposed widening in addition to a fourth culvert that conveys flow for Mill Creek North.

Just west of NE 92nd Avenue, Mill Creek is conveyed under SR 502 through two 6-foot-diameter multiplate culverts. The multiplate culverts do not appear to be perched (invert elevated above the natural creek bed) and has some fine-grained sediments deposited along the barrel invert when examined in the fall of 2007.

Just east of NE 72nd Avenue, a concrete box culvert conveys Mill Creek under SR 502. Bed load in the culvert's entrance contained cobbles and gravels, in addition to some finer-grained materials when examined in the fall of 2007. The culvert also does not appear to be perched.

Just south of SR 502, Mill Creek is contained in a concrete arch culvert under NE 72nd Avenue. Deposition of fine-grained materials was observed under part of the arch when examined in the fall of 2007. In addition, a box culvert under SR 502 near NE 64th Avenue conveys flow under SR 502 for Mill Creek North. Based upon site visit photos obtained by the biological survey team, scour does not appear to pose a problem at any of the existing structures.

3.3.10 Drainage Area

The drainage area of Mill Creek at the crossing just west of NE 92nd Avenue is 3.9 square miles, expanding to 5.14 square miles at NE 72nd Avenue. At its mouth, the total drainage area of Mill Creek is 12 square miles.

3.3.11 Potential for Watershed Changes

The magnitude of flood peaks could be modified by potential future watershed changes, such as increased runoff due to upstream development or construction of regional stormwater detention facilities. Clark County's stormwater development ordinances require stormwater detention to avoid increasing runoff on downstream properties, among other water quantity and quality requirements. However, some increase in runoff could be reasonably anticipated in the future as the land use shifts away from open pastures and agriculture to more urban residential and commercial development, which might increase the peak discharge on Mill Creek.

The timeframe for the Mill Creek floodplain to become developed is uncertain due to the unknown future pace of development. However, Clark County regulations for stormwater and preservation of flood storage capacity should serve to minimize and potentially offset any potential future discharge increases related to development.

The potential for an increased peak discharge depends upon the effectiveness of the stormwater facilities constructed and the maintenance performed. One additional approach to mitigating for the increased runoff potential due to development involves the construction of a regional stormwater facility, which can provide a community with an approach to controlling runoff bound for a waterway. Since no appreciable increase in discharge is expected, in combination with future development providing erosion and stormwater controls, the future sediment load would be expected to remain relatively consistent.

3.3.12 Flow Patterns during Flood Events

FEMA's FIS indicates that Mill Creek floods similarly to other waterways in the area. Climatic conditions produce high flows during the winter when precipitation is more frequent. Low flows occur in the summer as a response to the dry warmer weather typical of this season in the Pacific Northwest. Backwater from Salmon Creek only affects flood elevations on Mill Creek at their confluence, and Salmon Creek floods do not impact Mill Creek flood elevations within the project corridor.

4.0 Effects and Benefits

This section identifies potential effects and benefits to water quality, groundwater, surface water, and floodplains associated with the No Build Alternative and the Build Alternative. Effects and benefits are discussed in terms of temporary effects associated with construction activities, and long-term effects associated with the operation and maintenance of the facility or permanent changes resulting from the project. Indirect and cumulative effects of the project are documented in a separate report, *Indirect Effects and Cumulative Effects Discipline Report* (Parsons Brinckerhoff, 2008c).

4.1 Temporary Effects and Benefits

4.1.1 No Build Alternative

Under the No Build Alternative, the existing SR 502 corridor would not be retrofitted with stormwater treatment, and stormwater runoff will continue to discharge as it does under existing conditions. No changes to the quality of groundwater resources due to roadway construction would occur. No changes in the floodplain conditions and flood storage capacity of the floodway of Mill Creek Mill Creek North would occur. None of the culverts would be extended or replaced and no work would occur below the Ordinary High Water Mark (OHWM) of Mill Creek and Mill Creek North. No restoration or rehabilitation work would occur at the Sunset Oaks or Mill Creek North mitigation sites.

4.1.2 Build Alternative

Under the Build Alternative, the existing SR 502 Corridor would be widened and stormwater treatment would be added to both the new impervious surface as well as retrofitting a portion of the existing impervious surface. No changes in the quality of groundwater resources as a result of roadway construction are expected to occur. The proposed fill associated with the Build Alternative is not anticipated to significantly modify the floodplain functions of the study area. Four culverts would be replaced and the replacement culverts would enhance fish passage. Restoration and rehabilitation work would occur at the Sunset Oaks and Mill Creek North mitigation sites.

Surface Water

Effects of the project to water quality could occur where the proposed work is near Mill Creek, Mill Creek North, unnamed tributaries to Gee Creek and the East Fork Lewis River, and near or in the wetlands. The project would result in between 8 and 15 acres of wetlands being filled; direct wetland effects would occur for all categories (I – IV) of wetlands found in the study area. Additional direct wetland effects may occur as the project design evolves and stormwater features are developed.

Portions of the proposed culvert extensions would impact areas below the OHWM for two crossing of Mill Creek and for culvert replacement for Mill Creek and Mill Creek North. The project would result in between 0.25 and 0.50 acre of impact below the OHWM for Mill Creek and Mill Creek North. This impact includes all four crossings. This estimate is based upon the area between the cut fill lines for the expanded roadway prism and intersecting the OHWM for each water crossing.

It should be noted that any discharge of stormwater during construction will require a National Pollutant Discharge Elimination System (NPDES) permit to be obtained from Ecology. Temporary Erosion and Sediment Control (TESC) as well as Spill Prevention Control & Countermeasures (SPCC) BMPs will be implemented and maintained in accordance with the NPDES permit and the *2006 WSDOT HRM*. Best Management Practices (BMPs) for construction will be employed to avoid and minimize impacts to water quality from grading and construction work that exposes erodible soils and increases storm runoff rates as a result of soil exposure and compaction. To minimize the risks of fuel and hydraulic leaks or spills from construction machinery, an SPCC plan will be developed.

Erosion from exposed soils (either disturbed soil areas or soil stockpiles) during construction could increase the amount of sediment, suspended solids and turbidity entering Mill Creek, Mill Creek North, unnamed tributaries to Gee Creek and the East Fork Lewis River, and adjacent wetlands. Effects due to erosion will be prevented by implementation of appropriate conservation measures in the project's TESC plan. No work is expected in erosion hazard zones because much of the study area is underlain by silt loam from various soil series with zero to eight percent slopes.

Construction activities in areas of known or potential soil and/or groundwater contamination are described in the *Final Hazardous Materials ISA-Level Discipline Report* (Parsons Brinckerhoff, 2008b) prepared for this project. Similar water quality impacts could occur for Curtin Creek and North Mill Creek during construction activities at these mitigation sites.

Clearing and grading would occur in the study area along the SR 502 corridor. Clearing and grading would occur off of the current shoulder of the eastbound and westbound lanes as the road is widened. The total area proposed for clearing and grading is 70 acres. The newly widened areas would be the sources for any potential water quality problems in addition to project staging areas. The locations of project staging areas are unknown at this point; however, staging areas can be sites of increased disturbance and erosion.

Increased stormwater runoff due to an increase of impervious area could combine with erosion from construction grading, machine operation and vegetation removal to decrease water quality. Stormwater runoff may also carry other contaminants, such as fuel or oil from construction operations, particularly at staging areas. Spills from construction equipment at project staging areas or within the project construction limits could occur. Pouring concrete near open water would create the potential for spills. Concrete spilled into open waters can impact local pH by raising the pH due to the alkaline nature of the cement component of concrete. Highly alkaline water is toxic to fish and other aquatic life.

The construction season is not defined, but construction would likely occur during the summer. Because of low precipitation rates in the summer, waterways in the study area will contain lower flows. Due to the lower summer flows, erosion or contaminants that reach streams in the summer may represent higher concentrations in stream relative to other times of the year. However, there is a decreased likelihood of spills, sediment, and high pH water reaching surface waters because of low precipitation and associated stormwater at this time of the year.

Groundwater

Construction activities that require vegetation clearing, soil compaction, and other practices that decrease the permeability of ground surface and impede infiltration of rainfall can potentially affect groundwater resources. Spills from construction equipment, if not properly contained and cleaned-up, can enter and impact the shallow aquifer.

No substantially contaminated sites were identified that would pose a substantial effect during project construction. Ten sites containing known or potential hazardous materials were identified within 1,000 feet of the proposed project improvements; however, hazardous materials at these sites are considered reasonably predictable in nature because of each sites documented environmental history, the contaminants of concern, their physical location in relation to the

study area, and/or current site conditions. Four of the ten sites are considered high potential effect due to documented onsite contamination and project acquisitions planned at these sites.

Partial acquisitions are planned at five of the ten hazardous materials sites identified in the study area. These five sites are located near the intersection of SR 502 and NE 72nd Avenue; further investigation of these hazardous materials sites is recommended. The potential exists for WSDOT to incur liability issues associated with acquisition and/or construction at these sites from contaminated soil and/or groundwater.

Floodplains

During construction, the minor grading associated with the build alternative could potentially redirect and/or obstruct the flow of runoff or floodwaters. Once the grading is completed and the stormwater facilities operational, the potential temporary floodplain effects would be eliminated.

4.2 Long Term Effects and Benefits

4.2.1 No Build Alternative

Under the No Build Alternative, the existing SR 502 corridor would not be retrofitted with stormwater treatment, and stormwater runoff will continue to discharge as it does under existing conditions. No changes to the quality of groundwater resources due to roadway construction would occur. No changes in the flood storage capacity of the floodway of Mill and Curtin Creeks would occur.

4.2.2 Build Alternative

Surface Water

The nine minimum requirements identified in Section 3-3 of the *2006 WSDOT HRM* apply to this project with the Preliminary Hydrology Analysis focusing on runoff treatment and flow control. Stormwater volume will be released at Washington Department of Ecology's Western Washington standards.

For runoff treatment, the project would meet the Basic Treatment threshold, as set by the *2006 WSDOT HRM*, of 5,000 square feet or more PGIS for each Threshold Discharge Area (TDA). The project would be designed to meet the Basic Treatment performance goal of removing 80% of total suspended solids (TSS). Additionally, the project would provide Enhanced Treatment to all of the TDAs requiring basic treatment because design year average daily traffic (ADT) is projected to be greater than 30,000 and listed fish-bearing streams will be the receiving waterbodies for stormwater runoff from the project.

Currently, no stormwater treatment is provided for impervious surfaces within the study area. The project would provide enhanced treatment for approximately 28 acres of new PGIS, and would retrofit approximately 6 acres of existing PGIS for a total of approximately 34 acres of PGIS being treated (Exhibit 8). These quantities may change as design progresses; however, the overall conclusions of this report would not change**.**

Exhibit 8. Threshold Discharge Areas (TDAs) Build Alternative Modifications

TDA	Amount Existing Impervious (acres)	Increase in Impervious Due to Build Alternative (Net New) (acres)	Total Impervious After Completion of Build Alternative (acres)	Total Impervious Proposed to be Untreated (acres)	Amount Total Impervious Treated by BMPs (acres)
TDA 1	0.32	0.03	0.35	0.25	0.10
TDA 2	1.79	1.82	3.61	1.20	2.41
TDA 3	3.28	4.95	8.23	2.48	5.75
TDA 4	1.80	2.74	4.54	1.45	3.09
TDA 5	8.74	11.16	19.90	6.81	13.09
TDA 6	3.20	3.34	6.54	2.26	4.28
TDA 7	3.39	3.58	6.97	2.07	4.90
TDA 8	0.09	0.07	0.16	0.05	0.11
TOTALS	**22.61**	**27.69**	**50.30**	**16.57**	**33.73**
APPROXIMATE TOTALS	**23**	**28**	**51**	**17**	**34**

Note: These quantities may change as design progresses

Based on the project's stormwater runoff estimates and hydraulic conditions in the project area, it is anticipated that 10 stormwater detention ponds would be required to capture and treat runoff from the impervious surfaces within the project area. Each detention pond would be constructed wetlands that provide stormwater treatment in addition to stormwater detention. Two detention ponds, both approximately 0.5 acres in size, would be located between NE 15th Avenue and NE 22nd Avenue; one on the north side and one on the south side of SR 502. Two detention ponds, approximately 0.5 acres and 1.1 acres in size, would be located on the north side of SR 502 between NE 22nd Avenue and NE 29th Avenue. One detention pond, approximately 0.6 acres in size, would be located on the south side of SR 502 just west of NE 42nd Avenue and one detention pond, approximately 0.3 acres in size, would be located on the north side of SR 502 just east of NE 42nd Avenue. The largest detention pond would be approximately 1.9 acres in size and would be located on the north side of SR 502 between NE 50th Avenue and NE 67th Avenue. The remaining three detention ponds would be located on the north side of SR 502; one west of NE 72nd Avenue (approximately 0.3 acres in size), one east of NE 72nd Avenue (approximately 1.2 acres in size), and one east of NE 92nd Avenue (approximately 0.7 acres in size). The final number, size and location of each detention pond could change as the design is finalized.

The water volumes would be released from the detention ponds per Washington State Department of Ecology standards for western Washington.

With the improved stormwater treatment associated with the project, the Build Alternative would still result in a dramatic decrease in TSS being discharged and a slight increase in total and dissolved metals being discharged. The slight increase in metals being discharged would likely result in a very slight decrease in fish habitat quality within the Mill Creek and Mill Creek North within the action area. However dilution modeling performed to support the Biological Assessment for this project shows that the metal concentrations would reach background levels within a few feet (or less) of entering the waterbodies. These increases in pollutant loadings would also be offset by habitat improvements, culvert replacements, riparian vegetation restoration and other compensatory mitigation measures as described in the Biological Assessment.

The stormwater management system would be designed to treat 91% of the estimated runoff for the post-developed condition, in accordance with WSDOT standards. Stormwater conveyance and treatment would be designed, constructed and maintained in accordance with the *2006 WSDOT HRM*. The Preliminary Hydrology Analysis Report for the project contains details on the proposed locations of water quality facilities, water quantity BMPs for highway runoff and stormwater management requirements. Exhibit 9 through Exhibit 14 present the estimated mean annual pollutant loads from the PGIS for each of the TDAs for both the No Build Alternative and Build Alternative using the Level 1 Stormwater Analysis from WSDOT's 2008 *BA Writer's Guidance for Preparing the Stormwater Section of Biological Assessments* (for TSS, TZn, DZn, TCu, and DCu) and Method 1 of WSDOT's 2006 *Quantitative Procedures for Water Quality Impact Assessments* (for TP).

Exhibit 11 through Exhibit 14 presents the estimated mean annual pollutant loads for total and dissolved zinc and total and dissolved copper, respectively. The "total" values of these pollutants include the "dissolved" and "particulate" forms of the pollutant. The dissolved form of the pollutant is available for ingestion and absorption by fish (bioavailable), whereas the particulate form usually settles out of the water column and is not bioavailable. The exposure to increased annual loads of dissolved zinc and copper may affect juvenile fish species in terms of reduced growth, depressed immunity, and olfactory impairment.

The values presented in Exhibit 9 compare the TSS change between the existing impervious without treatment and the existing and new impervious with treatment for the Build Alternative. The negative values in TSS Change with Treatment indicate a net benefit as a result of the Build Alternative over existing conditions.

These values assume no treatment of TSS from the approximately 23 acres of existing PGIS for the No Build Alternative and treatment of TSS from approximately 34 acres of existing and new PGIS for the Build Alternative. The estimated mean annual load of TSS from untreated PGIS is 565 pounds per acre. The estimated mean annual load of TSS from treated PGIS is 45 pounds per acre.

Exhibit 9. Predicted Annual Effluent Load for Total Suspended Solids (TSS)

TDA	TSS from Existing Impervious (pounds)	TSS from Existing and New Impervious with treatment (pounds)	TSS Change Due to Build Alternative with treatment (pounds)
TDA 1	180.80	145.75	-35.05
TDA 2	1,011.35	786.45	-224.90
TDA 3	1,853.20	1,659.95	-193.25
TDA 4	1,017.00	958.30	-58.70
TDA 5	4,938.10	4,436.70	-501.40
TDA 6	1,808.00	1,469.50	-338.50
TDA 7	1,915.35	1,390.05	-525.30
TDA 8	50.85	33.20	-17.65
TOTALS	**12,774.65**	**10,879.9**	**-1,894.75**

The values presented in Exhibit 10 compare the Total Phosphorus change between the existing impervious without treatment and the existing and new impervious with treatment for the Build Alternative. The negative values in Total Phosphorus Change with Treatment indicate a net benefit as a result of the Build Alternative over existing conditions while positive values indicate a net impact (albeit very minor) as a result of the Build Alternative over existing conditions.

These values assume no treatment of Total Phosphorus from the approximately 23 acres of existing PGIS for the No Action Alternative and treatment of Total Phosphorus from approximately 34 acres of existing and new PGIS for the Build Alternative. The estimated mean annual load of Total Phosphorus from untreated PGIS is 1.2 pounds per acre respectively. The estimated mean annual load of Total Phosphorus from treated PGIS is 0.30 pounds per acre.

Exhibit 10. Predicted Annual Effluent Load for Total Phosphorus

TDA	Total Phosphorus from Existing Impervious (pounds)	Total Phosphorus from Existing and New Impervious with treatment (pounds)	Total Phosphorus Change Due to Build Alternative with treatment (pounds)
TDA 1	0.38	0.33	-0.05
TDA 2	2.15	2.16	0.01
TDA 3	3.94	4.70	0.77
TDA 4	2.16	2.67	0.51
TDA 5	10.49	12.10	1.61
TDA 6	3.84	4.00	0.16
TDA 7	4.07	3.95	-0.11
TDA 8	0.11	0.09	-0.02
TOTALS	**27.13**	**30.00**	**2.88**

The values presented in Exhibit 11 compare the Total Zinc change between the existing impervious without treatment and the existing and new impervious with treatment for the Build Alternative. The negative values in Total Zinc Change with Treatment indicate a net benefit as a result of the Build Alternative over existing conditions while positive values indicate a net impact (albeit very minor) as a result of the Build Alternative over existing conditions.

These values assume no treatment of Total Zinc from the approximately 23 acres of existing PGIS for the No Action Alternative and treatment of Total Zinc from approximately 34 acres of existing and new PGIS for the Build Alternative. The estimated mean annual load of Total Zinc from untreated PGIS is 1.1 pounds per acre respectively. The estimated mean annual load of Total Zinc from treated PGIS is 0.28 pounds per acre.

Exhibit 11. Predicted Annual Effluent Load for Total Zinc

TDA	Total Zinc from Existing Impervious (pounds)	Total Zinc from Existing and New Impervious with treatment (pounds)	Total Zinc Change Due to Build Alternative with treatment (pounds)
TDA 1	0.35	0.30	-0.05
TDA 2	1.97	1.99	0.03
TDA 3	3.61	4.34	0.73
TDA 4	1.98	2.46	0.48
TDA 5	9.61	11.16	1.54
TDA 6	3.52	3.68	0.16
TDA 7	3.73	3.65	-0.08
TDA 8	0.10	0.09	-0.01
TOTALS	**24.87**	**27.67**	**2.80**

The values presented in Exhibit 12 compare the Dissolved Zinc change between the existing impervious without treatment and the existing and new impervious with treatment for the Build Alternative. The negative values in Dissolved Zinc Change with Treatment indicate a net benefit as a result of the Build Alternative over existing conditions while positive values indicate a net impact (albeit very minor) as a result of the Build Alternative over existing conditions.

These values assume no treatment of Dissolved Zinc from the approximately 23 acres of existing PGIS for the No Action Alternative and treatment of Dissolved Zinc from approximately 34 acres of existing and new PGIS for the Build Alternative. The estimated mean annual load of Dissolved Zinc from untreated PGIS is 0.35 pounds per acre. The estimated mean annual load of Dissolved Zinc from treated PGIS is 0.17 pounds per acre.

Exhibit 12. Predicted Annual Effluent Load for Dissolved Zinc

TDA	Dissolved Zinc from Existing Impervious (pounds)	Dissolved Zinc from Existing and New Impervious with treatment (pounds)	Dissolved Zinc Change Due to Build Alternative with treatment (pounds)
TDA 1	0.11	0.10	-0.01
TDA 2	0.63	0.83	0.20
TDA 3	1.15	1.85	0.70
TDA 4	0.63	1.03	0.40
TDA 5	3.06	4.61	1.55
TDA 6	1.12	1.52	0.40
TDA 7	1.19	1.56	0.37
TDA 8	0.03	0.04	0.00
TOTALS	**7.91**	**11.54**	**3.61**

The values presented in Exhibit 13 compare the Total Copper change between the existing impervious without treatment and the existing and new impervious with treatment for the Build Alternative. The negative values in Total Copper Change with Treatment indicate a net benefit as a result of the Build Alternative over existing conditions while positive values indicate a net impact (albeit very minor) as a result of the Build Alternative over existing conditions.

These values assume no treatment of Total Copper from the approximately 23 acres of existing PGIS for the No Action Alternative and treatment of Total Copper from approximately 34 acres of existing and new PGIS for the Build Alternative. The estimated mean annual load of Total Copper from untreated PGIS is 0.2 pounds per acre. The estimated mean annual load of Total Copper from treated PGIS is 0.065 pounds per acre.

Exhibit 13. Predicted Annual Effluent Load for Total Copper

TDA	Total Copper from Existing Impervious (pounds)	Total Copper from Existing and New Impervious with treatment (pounds)	Total Copper Change Due to Build Alternative with treatment (pounds)
TDA 1	0.06	0.06	0.00
TDA 2	0.36	0.40	0.04
TDA 3	0.66	0.87	0.21
TDA 4	0.36	0.49	0.13
TDA 5	1.75	2.21	0.46
TDA 6	0.64	0.73	0.09
TDA 7	0.68	0.73	0.05
TDA 8	0.02	0.02	0.00
TOTALS	**4.52**	**5.51**	**0.98**

The values presented in Exhibit 14 compare the Dissolved Copper change between the existing impervious without treatment and the existing and new impervious with treatment for the Build Alternative. The negative values in Dissolved Copper Change with Treatment indicate a net benefit as a result of the Build Alternative over existing conditions while positive values indicate a net impact (albeit very minor) as a result of the Build Alternative over existing conditions.

These values assume no treatment of Dissolved Copper from the approximately 23 acres of existing PGIS for the No Action Alternative and treatment of Dissolved Copper from approximately 34 acres of existing and new PGIS for the Build Alternative. The estimated mean annual load of Dissolved Copper from untreated PGIS is 0.053 pounds per acre. The estimated mean annual load of Dissolved Copper from treated PGIS is 0.035 pounds per acre.

Exhibit 14. Predicted Annual Effluent Load for Dissolved Copper

TDA	Dissolved Copper from Existing Impervious (pounds)	Dissolved Copper from Existing and New Impervious with treatment (pounds)	Dissolved Copper Change Due to Build Alternative with treatment (pounds)
TDA 1	0.02	0.02	0.00
TDA 2	0.09	0.15	0.06
TDA 3	0.17	0.33	0.16
TDA 4	0.10	0.19	0.09
TDA 5	0.46	0.82	0.36
TDA 6	0.17	0.27	0.10
TDA 7	0.18	0.28	0.10
TDA 8	0.00	0.01	0.00
TOTALS	**1.20**	**2.07**	**0.87**

The proposed runoff treatment and flow control BMPs for the project are the Combined Stormwater Treatment Wetland/Detention Pond BMP. The BMP is suitable for the topography and the aesthetic of the site. It would also complement existing wetlands in the project vicinity. The proposed stormwater treatment design may change depending on encountered site conditions and as final design progresses.

Groundwater

Groundwater quality is not expected to be affected by the Build Alternative. The net increase in impervious surface would not result in the diversion from groundwater infiltration to surface waters as the existing conditions assumes no infiltration and all runoff reaches surface waters. This is not anticipated to reduce recharge to the shallow aquifer nor would it affect the deeper aquifers or have an impact on the water quality of the Troutdale Sole Source Aquifer, due to the confining silt and clay layer between the shallow and deep aquifers and the fact that most recharge areas occurs east of the study area in the Cascade foothills.

There would be no long-term adverse effects to or from hazardous materials.

Remediating known or potentially contaminated hazardous materials sites for the project would benefit the study area. Removing these materials from the area as eliminates the potential health hazards and liability risks from these materials remaining in the area.

Floodplains

As a result of construction, fill would be placed within the floodplain of Mill Creek; however, due to relative flatness of the corridor, no major fills are proposed. The primary floodplain

effects would occur just west of NE 67th Avenue for fill placed south and north of SR 502. The floodplain in this area predominantly contains open pastures, rural residential development, and agricultural fields. Within Battle Ground, the land use varies to include some urban residential and commercial development.

To accommodate Mill Creek four structures are proposed to be modified or replaced. The two multiplate culverts under SR 502 just west of NE 92nd Avenue would be replaced with a single fish-passable culvert. The box culvert under SR 502 just east of NE 72nd Avenue would be replaced, and the culvert under NE 72nd Avenue just south of SR 502 would also be replaced. These modifications are not expected to modify the floodplain functions of the Mill Creek.

To accommodate Mill Creek North, the culvert under SR 502 west of NE 67th Avenue may be extended or replaced with a fish passable culvert. Although the culvert performance should increase, due to the backwater effects of Mill Creek and the flatness of the terrain in the vicinity of Mill Creek North, the floodplain function of Mill Creek North is not expected to change as a result of culvert modification.

The proposed fill for the SR 502 widening falls outside of the FEMA-designated floodway but within the 100-year floodplain on Mill Creek. While the proposed fill does remove some flood storage capacity, the fill would be placed in non-conveyance areas in contrast to removing conveyance from the creek's channel. To comply with Clark County's regulations requiring no net loss of flood storage capacity, the design will create compensatory flood storage to mitigate for the floodplain fill.

As the project and associated fill is not anticipated to significantly modify the floodplain functions of the study area, only minor mitigation is anticipated in the form of creation of compensatory flood storage for the fill. The creation of flood storage as mitigation represents a cost effective approach.

The proposed rehabilitation and restoration activities at Mill Creek North would likely increase the flood storage capacity due to the realignment into a new wider channel, the construction of side channels, and the retention of the existing channel as an overflow channel.

4.3 Permits Required

All work below OHWM for culvert modifications would require a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers and from Ecology. Culvert modifications would also require a Hydraulic Project Approval from the Washington Department of Fish and Wildlife. A Clean Water Act Section 401 Water Quality Certification would also be required from Ecology to support the Section 404 permit. The project would also need a National Pollutant Discharge Elimination System Construction Stormwater Permit from Ecology. Floodplain-related permits required for the proposed widening include a floodplain permit from Clark County due to the proposed fill within the FEMA-designated 100-year floodplain and the modification of structures, some within the floodway. Mitigation anticipated for the floodplain permit includes the removal of material within the floodplain to compensate for the placed fill, such that no net loss of flood storage capacity occurs.

5.0 Conservation and Mitigation

This section discusses potential conservation and mitigation measures that could be used to avoid or minimize effects on water quality and quantity. Potential mitigation measures are discussed for the temporary effects and the long-term effects of the Build Alternative only.

5.1 Conservation Measures for Temporary Effects

The following conservation measures could be taken to avoid and minimize temporary effects on water quality and quantity. Conservation measures include:

- A Temporary Erosion and Sediment Control (TESC) plan shall be prepared prior to the start of construction and adhered to throughout the process. All reasonable measures should be used to assure that construction activity will be in compliance with local and state standards.

- During project construction, all erosion and stormwater control measures will aim to either meet or exceed the *2008 WSDOT HRM* requirements.

- Stormwater discharges from the project site meeting the NPDES General Construction Stormwater permit benchmark from 0 to 25 NTU are presumed to be in compliance with the state surface water quality standards (Chapter 173-201 WAC). Construction monitoring would follow the *2008 WSDOT HRM* requirements.

- In addition to a TESC plan, the project will include a SPCC plan. These plans will guide actions to control spills and associated pollutants throughout the project work areas. SPCC plan components will include but are not limited to staging, storage, maintenance, refueling areas and waste sites. It would be the responsibility of the project sponsor and its contractors to structure their operations in a manner that reduces the risk of spills or the accidental exposure of fuels or hazardous materials to waterways or wetlands and provide for the prompt and effective cleanup of spills. The SPCC plan will help to avoid and mitigate when necessary for potential contaminant spills that could affect groundwater as there are public and private water wells in the study area.

- Spill control BMPs, including the SPCC Plan, proper storage, and containment facilities shall be used during construction to minimize the effects of a spill. Contractors are required to prepare and implement the SPCC Plan in accordance to WSDOT Standard Specification 1-07.15(1). Specific spill control BMPs can be found in Volume 2 of Ecology's Stormwater Runoff Manual for Western Washington.

5.2 Mitigation Measures for Temporary Effects

No additional mitigation measures are proposed because there would be no anticipated temporary effects on water quality and quantity.

5.3 Conservation Measures for Long Term Effects

The following conservation measures could be taken to avoid and minimize long-term effects on water quality and quantity. Conservation measures include:

- Stormwater treatment and flow attenuation would be a part of the project. The proposed locations of water quality and quantity BMPs for highway runoff as well as stormwater management requirements are described in the Preliminary Hydrology Analysis Report for the project.

- All stormwater facilities require routine inspection and maintenance and would be designed to facilitate these functions. Maintenance will be based on regular inspections as deemed necessary and by the level of funding provided by the Washington state legislature. Maintenance practices will follow WSDOT standards for protecting roads and the environment including the BMPs established in Section 5-5 of the *2008 WSDOT HRM*.

- To comply with FEMA's and Clark County's floodway criteria, the culvert replacements and extensions must not cause an increase in the 100-year floodway elevations, relative to the existing condition.

5.4 Mitigation Measures for Long Term Effects

The following mitigation measures could be taken to avoid and minimize long-term effects on water quality and quantity. Mitigation measures include::

- Wetland mitigation would likely involve a combination of wetland re-establishment, creation, rehabilitation, and/or enhancement. The *Wetland Discipline Report* presents Ecology's baseline replacement ratios for wetland mitigation, and the acreage of mitigation that would likely be required under each scenario. Buffers will be applied to all wetland mitigation areas in accordance with current state and federal guidelines, as published in *Wetlands in Washington State - Volume 2: Guidance for Protecting and Managing Wetlands* (2005c).

- When possible, trees removed from the riparian areas could be salvaged and used for woody debris placement within environmental mitigation sites.

- Disturbed riparian areas will be seeded to improve water quality and planted with woody species to provide long-term bank stabilization and in-stream shading.

- Because there are no existing stormwater treatment facilities, the project would retrofit approximately 6 acres of additional existing impervious surfaces for enhanced water quality treatment.

- Restoration activities should include restoration of in-stream habitat, stream channel reconstruction to restore natural channel morphology, reestablishment of floodplain connectivity, and restoration of riparian plant communities.

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7.0 Glossary

100-year floodplain	An area with a one percent chance of being flooded in any given year.
Alluvial sediments	Sediment is a general term for any unconsolidated particulate material that has been deposited by an agent of transport, such as water, ice, or wind. Alluvial sediment is unconsolidated particulate material that has been deposited by a river or stream.
Basalt	Basalt is a dark, fine-grained rock that forms when volcanic lava hardens. It often has a glassy appearance.
Best management practices	Physical, structural, and/or managerial practices that, when used singly or in combination, prevent or reduce pollutant discharge.
Clean Water Act 303(d) List	Section 303(d) of the federal Clean Water Act requires Washington State to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants.
Detention pond	A facility for temporarily holding stormwater runoff so that it can be released at a controlled rate.
Emergent wetlands	Wetlands dominated by herbaceous plants.
Endangered species	An endangered species is any species that is in danger of extinction throughout all or a significant portion of its range.
Floodway	The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base (100-year) flood without cumulatively increasing the water surface elevation more than a designated height. For Clark County, the designated height is one foot. (FEMA, NFIP Policy Index)
Hydrology	The science that relates to the occurrence, properties, and movement of water on the earth. It includes water found in the oceans, lakes, rivers, streams, and wetlands, as well as in upland areas, above and below ground, and in the atmosphere.
Impervious surface	Any surface, such as a rooftop, sidewalk, road, parking lot, and compacted urban soils, that prevents rain from passing through or penetrating and moving into soils as it would naturally.
Mitigation	The measures that could be taken to lessen the negative effects predicted for each resource. These measures may include reducing or minimizing a specific negative effect, avoiding it completely, or rectifying or compensating for the negative effect.

Ordinary High Water Mark (OHWM)	Physical mark along most waterways that indicates height normally reached during average high flow.
Pollutant	Any substance that upon reaching the environment (soil, water, or air), is degrading in effect so as to impair the environment.
Right of way	Right of way is the land set aside for use as a highway. Rights of way are purchased (acquired) prior to the construction of a new road. Usually enough extra land is purchased for the purpose of providing safety clearances, building retaining walls, and implementing other mitigation features.
Riparian area	A riparian area is an area of land covered by vegetation and adjacent to and influenced by streams, lakes, and open water wetlands.
Salmonid	Belonging to the family Salmonidea, including salmon, trout, and whitefish.
Sediment	A general term for any unconsolidated particulate material that has been deposited by an agent of transport, such as water, ice, or wind.
Spill Prevention, Control, and Countermeasures (SPCC)	A Spill Prevention, Control, and Countermeasures (SPCC) plan includes site information regarding hazardous materials, spill prevention and containment methods, response procedures, and equipment and material to carry out preventive and response measures. SPCC plans ensure that all harmful and/or deleterious materials are properly stored and contained.
Stormwater runoff	Stormwater runoff is the portion of precipitation (rainwater or snowmelt) that does not naturally seep into the ground or evaporate, but flows overland via ditches, surface flow, pipes, or other features into a defined surface water or treatment facility.
Temporary Erosion and Sediment Control (TESC)	A Temporary Erosion and Sediment Control (TESC) plan includes measures that may include, but are not limited to, the following (as necessary, depending on site conditions): temporary plastic cover, coir fabric (and/or wattles), seeding and mulching, temporary vegetated filter strips (i.e., for construction site stormwater control), slope drains, silt fence, sand, or geotextile-encased triangular silt dikes. The purpose of such a plan is to prevent and minimize erosion.
Threatened species	A threatened species is any species that is likely to become endangered within the foreseeable future.
Total Maximum Daily Loads (TMDLs)	A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

Total suspended solids	Total quantity of dispersed solids, such as fine material or soil particles, carried within a stream.
Tributary	A tributary is a stream that flows into a larger body of water.
Wetland delineation	To delineate a wetland means to identify the boundaries of the wetland. A wetland specialist uses a standard methodology to evaluate the soils, vegetation, and hydrology of the area that may be a wetland. The delineated boundary then is flagged in the field and surveyed.

Appendix A

List of Baseline Documentation

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Several studies, analyses and technical memoranda were prepared for the WSDOT for the project. These documents support the environmental evaluation presented in this technical memorandum and include:

- SR 502 Preliminary Hydrology Analysis
- SR 502 Draft Wetland Discipline Report
- SR 502 Draft Biology Discipline Report

Other technical reports and resources used include:

- Soil Survey of Clark County, Washington prepared by the United States Department of Agriculture's Natural Resources Conservation Service
- Federal Emergency Management Agency Flood Insurance Rate Maps
- United States Geological Survey 1:24,000 scale topographic maps

In addition to these technical reports, web-based resources from governing agencies were also used:

- WSDOT 2006 Quantitative Procedures for Water Quality Impact Assessment, http://www.wsdot.wa.gov/NR/rdonlyres/4A1328B5-0B23-4E78-9E5A-790E12A80843/0/QuantitativeProcedures.pdf
- WSDOT 2008 BA Writer's Guidance for Preparing the Stormwater Section of Biological Assessments, http://www.wsdot.wa.gov/NR/rdonlyres/634BEB16-F5B2-4DDE-B0CB-4BCF1D8F478B/0/BA_StormwaterGuidance.pdf
- Washington Department of Ecology, http://www.ecy.wa.gov/programs/eap/env-info.html
- United States Geological Survey, http://waterdata.usgs.gov/nwis/sw

Field reconnaissance and site visits confirmed data obtained from the above sources. Site photographs, aerial photographs and maps were also reviewed. Contacts were made with Clark County regulatory agencies regarding streamflow monitoring data.

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Appendix B

FEMA Flood Insurance Rate Maps

This appendix can be found in the .pdf version of this report.

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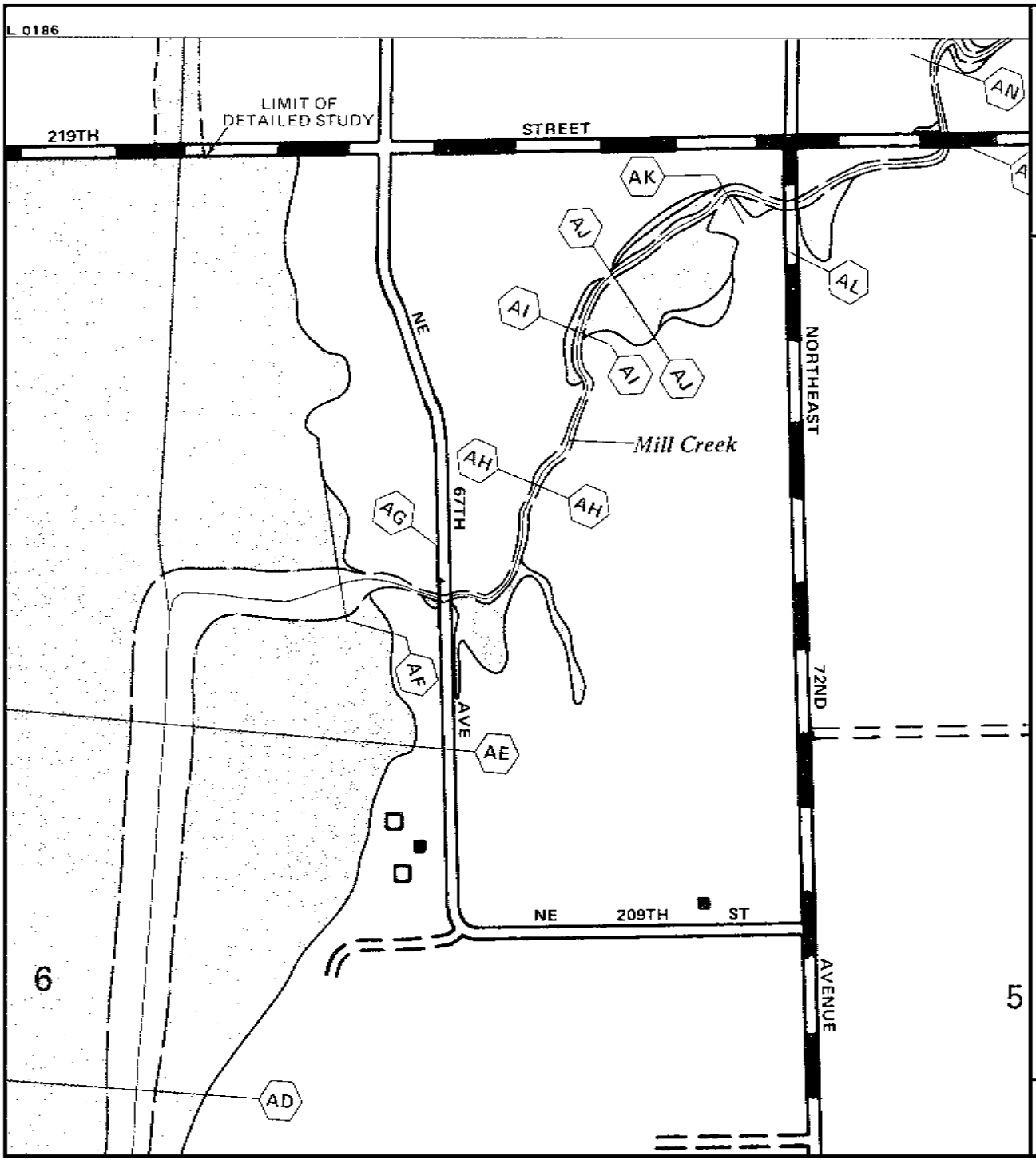

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APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FLOODWAY

FLOOD BOUNDARY AND FLOODWAY MAP

CLARK COUNTY, WASHINGTON

(UNINCORPORATED AREAS)

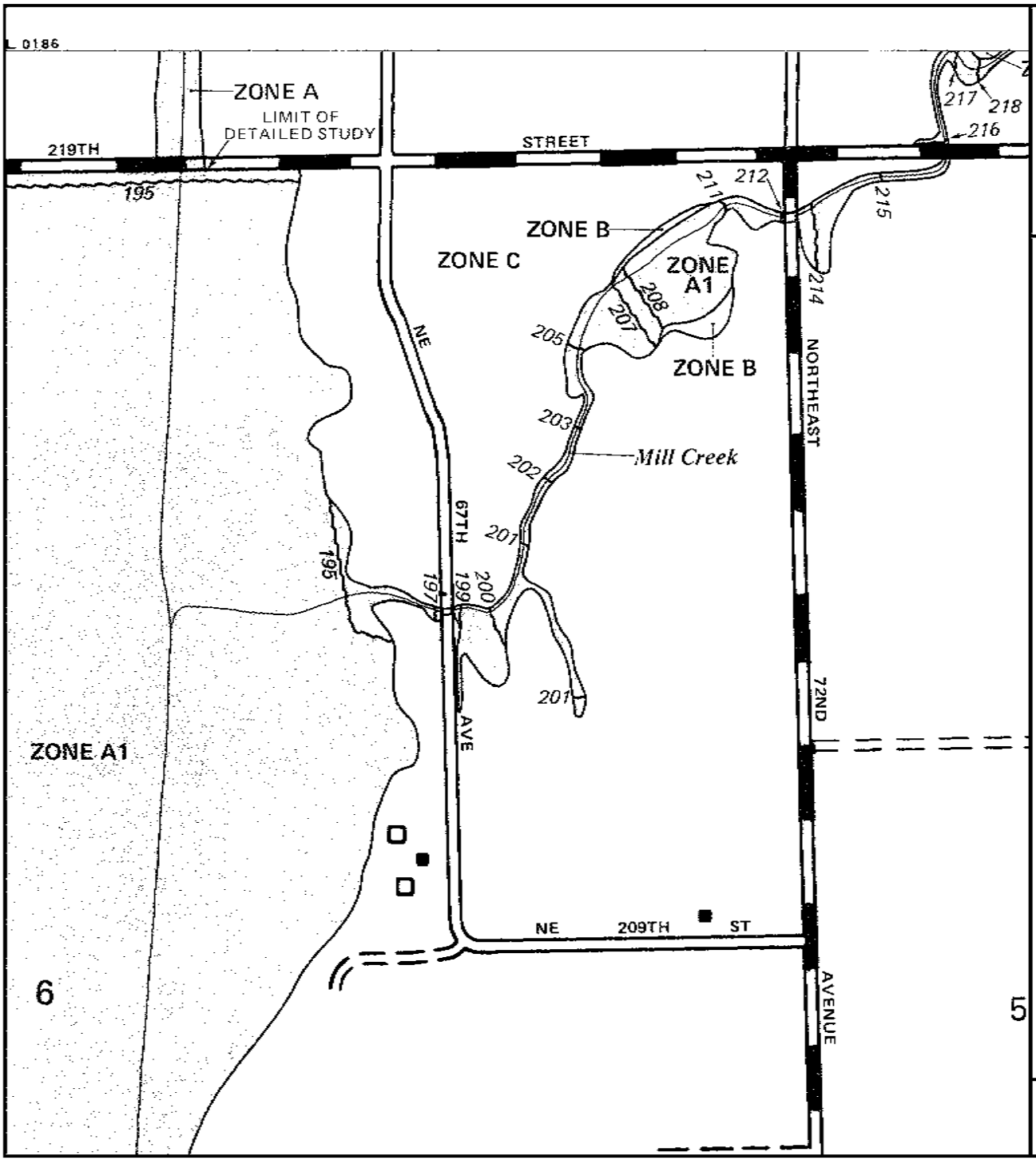
PANEL 188 OF 475

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
530024 0188

EFFECTIVE DATE:
AUGUST 2, 1982

Federal Emergency Management Agency



APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

CLARK COUNTY, WASHINGTON

(UNINCORPORATED AREAS)

PANEL 188 OF 475

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
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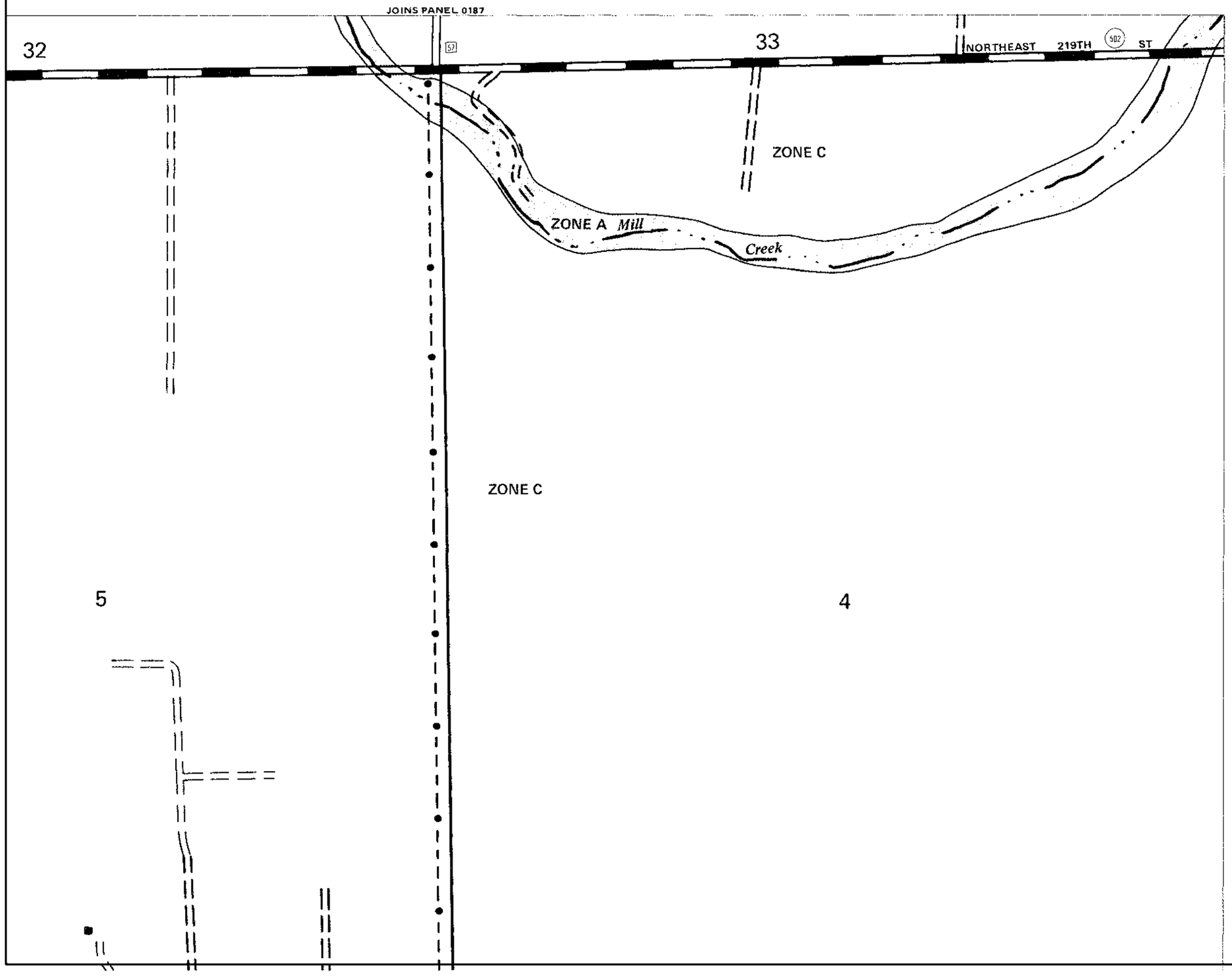
EFFECTIVE DATE:
AUGUST 2, 1982

Federal Emergency Management Agency



APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

CLARK COUNTY, WASHINGTON

(UNINCORPORATED AREAS)

PANEL 189 OF 475

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
530024 0189 B

EFFECTIVE DATE:
AUGUST 2, 1982

Federal Emergency Management Agency

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Appendix C

Pollutant Loading Spreadsheets

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TDA Summary

	Pre-Project (acres)		Pos-Project (acres)	
TDA	**Impervious**	**Pervious**	**Impervious**	**Pervious**
TDA 1	0.32	0.22	0.35	0.19
TDA 2	1.79	6.61	3.61	4.79
TDA 3	3.28	17.64	8.23	12.69
TDA 4	1.80	10.26	4.54	7.52
TDA 5	8.74	26.67	19.90	15.51
TDA 6	3.20	15.48	6.54	12.14
TDA 7	3.39	12.95	6.97	9.37
TDA 8	0.09	0.24	0.16	0.17
TOTALS	**22.61**	**90.07**	**50.30**	**62.38**
APPROXIMATE TOTALS	**23**	**90**	**51**	**63**

Note: These quantities may change as design progresses.

DATA ENTRY

	THRESHOLD DISCHARGE AREA (TDA)								TOTAL
	1	2	3	4	5	6	7	8	(acres)
EXISTING IMPERVIOUS									
PRE-PROJECT									
Existing **treated** impervious surface **with discharge** to waterbody (acres)									*0.00*
Existing impervious surface **infiltrated** (acres)									*0.00*
Existing **untreated** impervious surface (acres)	0.32	1.79	3.28	1.80	8.74	3.20	3.39	0.09	*22.61*
Total existing impervious surface (acres)	*0.32*	*1.79*	*3.28*	*1.80*	*8.74*	*3.20*	*3.39*	*0.09*	*22.61*
POST-PROJECT									
Existing impervious surface **retrofitted** for treatment **with discharge** to waterbody (acres)	0.07	0.59	0.80	0.35	1.93	0.94	1.32	0.04	*6.04*
Existing impervious surface **retrofitted for infiltration** (acres)									*0.00*
NEW IMPERVIOUS									
New **treated** impervious surface **with discharge** to waterbody (acres)	0.03	1.82	4.95	2.74	11.16	3.34	3.58	0.07	*27.69*
New impervious surface **infiltrated** (acres)									*0.00*
New **untreated** impervious surface (acres)									*0.00*
Total new impervious surface (acres)	0.03	1.82	4.95	2.74	11.16	3.34	3.58	0.07	*27.69*
TOTAL IMPERVIOUS									
Total impervious surface area **untreated** post-project (acres)	*0.25*	*1.20*	*2.48*	*1.45*	*6.81*	*2.26*	*2.07*	*0.05*	*16.57*
Total impervious surface area **treated** post-project with discharge to waterbody (acres)	*0.10*	*2.41*	*5.75*	*3.09*	*13.09*	*4.28*	*4.90*	*0.11*	*33.73*
Total impervious surface area **infiltrated** (acres)	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

LOAD CALCULATIONS

LOAD RATES	TSS	TOTAL PHOSPHORUS	TOTAL ZINC	DISSOLVED ZINC	TOTAL COPPER	DISSOLVED COPPER
Mean annual load from untreated surfaces (lbs/acre)	565	1.2	1.1	0.35	0.2	0.053
Mean annual load from treated surfaces (lbs/acre)	45	0.3	0.28	0.17	0.065	0.035

PROJECT TOTAL	TSS	TOTAL PHOSPHORUS	TOTAL ZINC	DISSOLVED ZINC	TOTAL COPPER	DISSOLVED COPPER
Annual effluent load from existing impervious surfaces prior to project (lbs)	12,774.65	27.13	24.87	7.91	4.52	1.20
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	28,419.50	60.36	55.33	17.61	10.06	2.67
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) without treatment	**15,644.85**	**33.23**	**30.46**	**9.69**	**5.54**	**1.47**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	10,879.90	30.00	27.67	11.53	5.51	2.06
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-1,894.75**	**2.87**	**2.80**	**3.62**	**0.98**	**0.86**

TDA BREAKDOWN	TSS	TOTAL PHOSPHORUS	TOTAL ZINC	DISSOLVED ZINC	TOTAL COPPER	DISSOLVED COPPER
TDA 1						
Annual effluent load from existing impervious surfaces prior to project (lbs)	180.80	0.38	0.35	0.11	0.06	0.02
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	197.75	0.42	0.39	0.12	0.07	0.02
NET CHANGE (lbs) without treatment	**16.95**	**0.04**	**0.03**	**0.01**	**0.01**	**0.00**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	145.75	0.33	0.30	0.10	0.06	0.02
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-35.05**	**-0.05**	**-0.05**	**-0.01**	**-0.01**	**0.00**
TDA 2						
Annual effluent load from existing impervious surfaces prior to project (lbs)	1,011.35	2.15	1.97	0.63	0.36	0.09
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	2,039.65	4.33	3.97	1.26	0.72	0.19
NET CHANGE (lbs) without treatment	**1,028.30**	**2.18**	**2.00**	**0.64**	**0.36**	**0.10**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	786.45	2.16	1.99	0.83	0.40	0.15
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-224.90**	**0.01**	**0.03**	**0.20**	**0.04**	**0.05**
TDA 3						
Annual effluent load from existing impervious surfaces prior to project (lbs)	1,853.20	3.94	3.61	1.15	0.66	0.17
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	4,649.95	9.88	9.05	2.88	1.65	0.44
NET CHANGE (lbs) without treatment	**2,796.75**	**5.94**	**5.45**	**1.73**	**0.99**	**0.26**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	1,659.95	4.70	4.34	1.85	0.87	0.33
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-193.25**	**0.77**	**0.73**	**0.70**	**0.21**	**0.16**

TDA BREAKDOWN	TSS	TOTAL PHOSPHORUS	TOTAL ZINC	DISSOLVED ZINC	TOTAL COPPER	DISSOLVED COPPER
TDA 4			ZINC			
Annual effluent load from existing impervious surfaces prior to project (lbs)	1,017.00	2.16	1.98	0.63	0.36	0.10
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	2,565.10	5.45	4.99	1.59	0.91	0.24
NET CHANGE (lbs) without treatment	**1,548.10**	**3.29**	**3.01**	**0.96**	**0.55**	**0.15**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	958.30	2.67	2.46	1.03	0.49	0.19
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-58.70**	**0.51**	**0.48**	**0.40**	**0.13**	**0.09**
TDA 5						
Annual effluent load from existing impervious surfaces prior to project (lbs)	4,938.10	10.49	9.61	3.06	1.75	0.46
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	11,243.50	23.88	21.89	6.97	3.98	1.05
NET CHANGE (lbs) without treatment	**6,305.40**	**13.39**	**12.28**	**3.91**	**2.23**	**0.59**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	4,436.70	12.10	11.16	4.61	2.21	0.82
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-501.40**	**1.61**	**1.54**	**1.55**	**0.46**	**0.36**
TDA 6						
Annual effluent load from existing impervious surfaces prior to project (lbs)	1,808.00	3.84	3.52	1.12	0.64	0.17
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	3,695.10	7.85	7.19	2.29	1.31	0.35
NET CHANGE (lbs) without treatment	**1,887.10**	**4.01**	**3.67**	**1.17**	**0.67**	**0.18**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	1,469.50	4.00	3.68	1.52	0.73	0.27
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-338.50**	**0.16**	**0.16**	**0.40**	**0.09**	**0.10**

TDA BREAKDOWN	TSS	TOTAL PHOSPHORUS	TOTAL ZINC	DISSOLVED ZINC	TOTAL COPPER	DISSOLVED COPPER
TDA 7						
Annual effluent load from existing impervious surfaces prior to project (lbs)	1,915.35	4.07	3.73	1.19	0.68	0.18
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	3,938.05	8.36	7.67	2.44	1.39	0.37
NET CHANGE (lbs) without treatment	**2,022.70**	**4.30**	**3.94**	**1.25**	**0.72**	**0.19**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	1,390.05	3.95	3.65	1.56	0.73	0.28
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-525.30**	**-0.11**	**-0.08**	**0.37**	**0.05**	**0.10**
TDA 8						
Annual effluent load from existing impervious surfaces prior to project (lbs)	50.85	0.11	0.10	0.03	0.02	0.00
Annual effluent load from new and existing impervious surfaces after project (lbs) **without** treatment	90.40	0.19	0.18	0.06	0.03	0.01
NET CHANGE (lbs) without treatment	**39.55**	**0.08**	**0.08**	**0.02**	**0.01**	**0.00**
Annual effluent load from new and existing impervious surfaces after project (lbs) **with** treatment	33.20	0.09	0.09	0.04	0.02	0.01
NET CHANGE in pollutant loads between pre- and post-project conditions (lbs) with treatment	**-17.65**	**-0.02**	**-0.01**	**0.00**	**0.00**	**0.00**