Table 3-3. Design Parameters for Inlet and Pipe Design

Design Parameter	WSDOT	ODOT	COP	COV
Runoff Time of Concentration, Tc	5 minutes	5 minutes	5 minutes	
Runoff Coefficient, C	0.90	0.90	0.92	
Allowable Spread, Zd	Shoulder Width OR Figure 5-4.1*	Shoulder Width or Table A**	Max Shoulder + 2 ft	
Inlet Grate Width & Length, GW & GL (ft)	1.67 or 3.89, 2.00 or 2.01	1'-1.5" or 2'-3.375", 2'-8" or 3'-4.25"	1'-1.5" or 2'-3.375", 2'-8" or 3'-4.25"	
Flow Bypass, Qbp	< 0.10 cfs to existing system or within hazardous areas	Per Method A		
Flow Velocity, v	<5.0 ft/s	> 3 ft/s		
Inlet Spacing	Min.= 20 ft, Max.= 300 ft, or Inlet Spacing Spreadsheet	Min = 10 ft, Max = 400 ft, or Inlet Design Computation Sheet		Max.= 400 ft
Pipe Length, L	Max.= 300 ft	Max = 400 ft		
Pipe Diameter, D	Min.= 12-inch	Min. = 45 inch	10 inch leads, 12 min.	Mainline: 12 inch Min. Lateral: 8 or 10 inch Only
Mean Rainfall Intensity, MRI	25 year (laterals and trunk lines) m= 6.06, n= 0.515	10 year, For zone 7	10 year	
Pipe: Time of Concentration, Tc	5 minutes	5 minutes	5 minutes	
Manning Roughness Coefficient, n	0.013	0.015	0.013	0.013
Pipe Velocity, v	10 ft/s max, 3 ft/s min.	3 ft/s min.	15 ft/s max; 2.5 ft/s min	

*WSDOT Hydraulics Manual 2010; Page 5-5
**ODOT Hydraulics Manual 2011; Page 13-D-1

Biofiltration Swales

Design and assumptions were developed into a template spreadsheet as a result of explicit design instructions found and followed in WSDOT HRM (WSDOT HRM Jan 2010; RT.04 – Biofiltration Swale; Pages 5-44 through 5-49: Method 1) Input Parameters are listed in Table 3-4.

Table 3-4. Design Parameters for Biofiltration Swale Design

Design Parameter	
Longitudinal Slope, s	Min. 1.5%, Max. 5.0%
Manning's Roughness Coefficient, n	0.22 (grass-legume mix on lightly compacted compost-amended soil) 0.35 (with surface roughening features if site constrained)
Residence Time, t	9 minutes

3.2 Stormwater Management Guidelines

The following demonstrates the design approach and methods of treatment within the following management parameters:

1. Treatment capacity design will meet standards and specifications found in HRM and thus exceed 50% of the 2-year, 24 hour storm; or 91% of the average annual runoff, as determined by continuous flow model.

2. Stormwater treatment will consist of one or more of the following methods:
    a. Bioretention ponds are infiltration ponds that use an engineered (amended) soil mix to remove pollutants as runoff infiltrates through this zone to the underlying soils. The primary mechanisms for pollutant reduction are filtration, sorption, biological uptake, and microbial activity. While this best management practice (BMP) is best suited to sites with Hydrologic Group A and B soils, it may be used for Group C and D Hydrologic Group soils with the addition of an underdrain system to collect infiltration runoff and direct it to a stormwater conveyance system. An infiltration rate of 1 inch per hour was assumed when estimating the size of these facilities. If the soils cannot sustain this rate and there is insufficient space to increase the pond size to accommodate a lower value, underdrains will be installed.
    b. Constructed treatment wetlands are shallow, permanent, vegetated ponds that function like natural wetlands. They remove pollutants through sedimentation, sorption, biological uptake, and microbial activity.
    c. Soil-amended biofiltration swales are trapezoidal channels with mild slopes and shallow depths of flow. The channels are dry between storm events and are typically vegetated. They treat runoff by filtration and sorption as runoff flows through the grass surface and amended soils. Amended soils, especially compost amended, constitute an excellent filtration medium. Compost-amended soils have a high cation exchange capacity that will bind and trap dissolved metals. Similar to bioretention ponds, an underdrain system is recommended for sites with Group C and D Hydrologic Group soils.
    d. Soil-amended filter strips treat sheet runoff from an adjacent roadway surface. Similar to grass swales, filter strips treat runoff by filtration and sorption as runoff flows through the vegetated surface and amended soils. In a confined urban setting such as the project corridor, opportunities to use this BMP are limited. Bioslopes, like filter strips, treat sheet runoff from an adjacent roadway surface. They comprise a vegetated filter strip, infiltration trench, and underdrain, and reduce pollutants through sorption and filtration. The percolating runoff flows through a special mixture of materials, including dolomite and gypsum, which promotes the adsorption of pollutants. Bioslopes are also known as media filter drains and ecology embankments.

Other water quality BMPs, including dispersal, drywells and proprietary systems, such as cartridge filters, may be used when limiting factors prevent the use of these BMPs are prevented by lack of suitable space, soils non-conducive to infiltration, polluted soils, and protection of historic building foundations. Pre-treatment facilities including baffle type oil-water separators and coalescing plate oil-water are likely also. Their use is common in high average daily trip areas to protect the treatment facilities and to prevent overwhelming of the treatment technology. Accidents and spills are expected to occur on interstate freeways.

All treatment facilities will be designed and engineered to use the preceding techniques singly, or in combination, to achieve treatment. Engineering criteria including facility dimensions, depth, area, slopes, and materials (abiotic and biotic); and design parameters from the WSDOT Runoff Manual (WSDOT 2010a) will be used and met when designing these facilities.

The project has agreed to adopt BMPs which are effective in reducing sediments, and particulate and dissolved metals. These agreements will be met. Specific locations of these facilities are described in additional volumes of this report and specific plan sheets for these facilities are located in Appendix C.

The following water quality BMPs used at Hayden Island Drive Interchange are effective in reducing sediments, and particulate and dissolved metals; pollutants of concern for ESA-listed species observed in the waterbodies to which stormwater will be discharged. These BMPs would be constructed for the sole purpose of improving stormwater runoff quality. The location of such facilities in the proximity of well-travelled roads and transit systems combined with ongoing maintenance would discourage their use as habitat by wildlife.

- **Constructed Treatment Wetlands**
- **Biofiltration Swales**

Other water quality approaches, including **Dispersal**, and **Proprietary Systems** (such as cartridge filters), have been considered on a case-by-case basis where the BMPs listed above would not be practical or feasible.

Oil control pretreatment may be required at high-traffic intersections and park-and-ride facilities where high concentrations of oil and grease are expected in stormwater runoff. **Baffle Type Oil-Water Separators** and **Coalescing Plate Oil-Water Separators** are considered to be suitable types of treatment facility.

As the project design progresses, the team will continue to assess new technologies and whether they should be added to the suite of acceptable BMPs. For example, the Washington State Department of Ecology recently approved (Ecology 2009c) Americast's Filterra® system for reducing, among other pollutants, dissolved metals. This system uses engineered bioretention filtration incorporated into a planter box to treat runoff.

The waterbodies to which runoff would be discharged are Columbia River mainstem and North Portland Harbor. Both contain species listed under the ESA, and all receiving watercourses are 303(d) listed. Note that although a watercourse may be 303(d) listed, the parameters listed may not necessarily have EPA-approved Total Maximum Daily Loads (TMDLs).

To address ESA and TMDL issues, the overall approach to stormwater management from a water quality perspective is to treat runoff to reduce the following pollutants that are typically associated with transportation projects[10]:

- debris and litter

[10] *Stormwater Management Plan Submission Guidelines for Removal/Fill Permit Applications Which Involve Impervious Surfaces.* State of Oregon Department of Environmental Quality. July 2005, 2008, 2012.

- suspended solids such as sand, silt, and particulate metals
- oil and grease
- dissolved metals

The last criterion, especially dissolved copper, is of particular concern to NMFS. Dissolved copper is known to have a detrimental effect on the olfactory senses of young salmonids.

Table 3-5 summarizes 303(d)-listed parameters and TMDLs for each receiving waterbody and the paragraphs following the table provide a brief description of existing water quality issues. Additional information may be found in the FEIS (CRC 2011).

Table 3-5. Listed Pollutants and TMDLs

Waterbody	303(d) Listed Pollutants	Established TMDLs
Columbia River and North Portland Harbor		
Oregon Department of Environmental Quality	Toxics (PCBs, PAHs, DDT/DDE, arsenic) Eutrophication (dissolved oxygen) Temperature	Dioxin Total dissolved gas
Washington Department of Ecology	Toxics (PCBs) Eutrophication (dissolved oxygen) Temperature	

The **Columbia River** and **North Portland Harbor** do not meet the Oregon DEQ standards and are 303(d) listed for the following parameters: temperature, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), dichloro-diphenyl-trichloroethane (DDT) metabolites (e.g., DDE), arsenic, and dissolved oxygen (DEQ 2009). The Columbia River is also on the Washington Department of Ecology's 303(d) list for temperature, PCBs, and dissolved oxygen (Ecology 2009a). In addition to the 303(d) listings, EPA has issued a TMDL for the Columbia River for dioxin (EPA 1991) and approved a TMDL for the Lower Columbia River for total dissolved gas (DEQ and Ecology 2002).

3.3 Other Requirements

3.3.1 Hazardous Wildlife

Airports have specific stormwater-related issues that should be noted. Ponds typically provided for stormwater flow control and treatment may be an attractant for wildlife considered hazardous to airport operations, specifically collisions between birds and aircraft approaching and departing from airports. While this is not likely to be an issue with Portland International Airport, it is a consideration for Pearson Airfield. For airports like Pearson that normally serve piston-powered aircraft, the Federal Aviation Administration (FAA) recommends a separation distance of 5,000 feet between any attractants such as stormwater ponds.

3.3.2 Oil Control

Oil control BMPs will be evaluated for Hayden Island interchange. At this time ODOT has not identified requirements for oil control at high use intersections.

3.4 Pipe Alternatives

Design calculations assume concrete pipe with a Mannings n of 0.013. Pipe diameters range from 12-inch to 24-inch. In some cases, pipe alternatives will be selected according to available cover and the expected traffic loading.

3.5 Downstream Analysis

Downstream analysis of the existing systems to determine capacity for use by upstream conveyance systems has not been performed physically or hydraulically modeled. The following provides a list of assumptions that identify the project's impact on the existing system:

- Stormwater runoff draining to CR-01/CR-02 will be through the new enclosed drainage system, as the existing drainage system will no longer function with the new roadway grades and alignments. The new enclosed drainage system connections to the existing outfalls will be immediately upstream of their actual outfall into the Columbia River. As a result, the pipe modeling spreadsheets will be used to confirm capacity.
- Stormwater runoff draining to outfall CR-01/CR-02 will receive less runoff from the local streets. The majority of the runoff from Jantzen, Tomahawk Island, Hayden Island Drives will be treated with stormwater planter strips which will take advantage of infiltrating the water quality volumes. Although the expected infiltration rates are low in this area, these localized systems will be shallow and provide greater available depth to water table.

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4. Developed Conditions

4.1 Proposed Drainage Sub-Basins

The limits of the drainage sub-basins are determined by the area draining to the outfall, whether on site or off site area is contributing. The outfalls are defined as the existing outfalls located along Columbia River's southern embankment. Within the sub-basins, CIAs are delineated according to water quality facility to which the stormwater runoff flows. Multiple water quality facilities may outflow to a common outfall, their cumulative areas comprising a single sub-basin, named for this outfall. The description of each outfall and their drainage basins are provided below.

Within the Columbia River South watershed there are two sub-basins impacted by the project. The outfalls to which these sub-basins flow are CR-01 and CR-02. Figure 4-1 shows the proposed Sub-basins and their associated general flow paths.

Within the sub-basins, CIAs are broken down by water quality facility to which the stormwater runoff flows. Multiple water quality facilities may outflow to a common outfall, their cumulative areas comprising a single sub-basin named for this outfall.

Table 4-1 summarizes the proposed CIA within The Columbia Slough watershed sub-basins, which will receive runoff treatment. A discussion of each sub-basin and the water quality facilities used to treat each basin's CIA follows. The locations of these facilities are shown in Appendix A. Note that the areas listed in the table below do not include potential staging areas.

Table 4-1. Proposed Drainage Sub-Basins

Sub-Basin	Total Area (acres)	Proposed Impervious Surfaces (acres)	Proposed Pervious Surfaces (acres)
CR-1	11.2	11.2	
CR-2	29.8	29.8	
NPH-1	2.9	2.9	
NPH-2	10.5	10.5	

Notes: Numbers may change with project design progression. Pervious surfaces will be included in the next phase of design.

CR-01 Outfall Sub-Basin

Runoff from proposed new, rebuilt and existing local streets and contiguous sidewalks within the CIA would be collected and treated primarily with stormwater planter strips. Proprietary systems such as cartridge filters will be used in a few areas without stormwater planters strips. These streets include Jantzen, Tomahawk Island, and Hayden Island Drives; Avenue A and the mainline connector arterial.

CR-02 Outfall Sub-Basin

Within this sub-basin the project will collect and treat stormwater runoff from following project areas:

- I-5 mainline between Tomahawk Island Drive and the Hayden Island Drive will be conveyed to a constructed treatment wetland CR-A located along the west side of the interchange.
- I-5 southbound highpoint on North Portland Harbor bridge to Tomahawk Island Drive, a portion of the LRT Arterial bridge, and nearby ramps will be routed to the CR-B constructed treatment wetland located along the northeast side of Jantzen Drive.
- I-5 from the Columbia River bridge highpoint to Hayden Island, LRT bridge at the CRC structure, Hayden Island Drive beneath I-5, nearby ramps, as well as a small section of the bike-pedestrian path will be conveyed to CR-C constructed wetland located in area of the existing Thunderbird hotel near the southern edge of the Columbia River.

Each of the water quality facilities will release outflows and high bypass flows downstream to a new stormwater outfall on the southern embankment of the Columbia River. The existing outfalls will need to be relocated due to proposed ground improvements in the area.

NPH-01 Outfall Sub-Basin

Within this CIA, the project will collect and treat project stormwater runoff draining from the highpoint at Marine Drive west to the project match line, via an enclosed drainage system and receive water quality treatment through a biofiltration swale. The water quality outflows and high bypass flows will be conveyed to through an existing 18-inch outfall pipe identified as NPH-01 that outflows into North Portland Harbor.

NPH-02 Outfall Sub-Basin

Within this CIA the project will collect and treat project stormwater runoff draining from I-5 mainline between the North Portland Harbor existing bridge highpoint and the lowpoint at Marine Drive Interchange; Marine Drive highpoint to the new bridge over the LRT guideway; LRT-arterial bridge from the highpoint to the southern abutment, and nearby ramps, via an enclosed drainage system and receive water quality treatment through a constructed wetland. The water quality outflows and high bypass flows will be conveyed to North Portland Harbor via outfall NPH-02. The new outfall for NPH-02 will replace the existing outfall that is in conflict with the LRT arterial bridge abutment wall located on south embankment of North Portland Harbor.

FIGURE 4-1.
PROPOSED DRAINAGE SUB BASIN
OREGON STATE - ICP

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5. Hydrologic and Hydraulic Design

5.1 Flow Control BMPs

Flow control is not required for runoff discharged into Columbia River.

5.2 Treatment BMPs

The primary proposed BMP water quality facilities in this watershed are constructed treatment wetlands. Constructed wetlands provide the surface area necessary to treat larger volumes of concentrated flows draining from the highways and interchanges. The constructed wetland design is based on Clean Water Services (CWS) guidelines for sizing wetlands. ODOT and COP currently do not have design guidelines available constructed wetlands.

The water quality treatment facilities volumes and flows were obtained using the guidelines outlined in Chapter 5 of the WSDOT HRM and the COP Stormwater Management Manual.

On a project and sub-basin level all contributing impervious surfaces will receive water quality treatment as defined in Section 3.2. The WSDOT software program, MGSFlood, was used to calculate the required water quality volume necessary to treat the upstream CIA. The CIA was obtained from quantity takeoffs via CAD Microstation design files.

Because no flow control is required for facilities draining into the Columbia River a flow splitter will be installed upstream of each facility. The splitter will convey the water quality flow (from the 2-yr-24-hr design storm depth) to the facility while bypassing the remainder to the outfall. The bypass and outlet pipes are assumed to be 12-inch diameter at this stage in design. Following are general assumptions used in the preliminary water quality facility design:

Biofiltration swale:

- MGSFlood Modeling used to calculate Runoff Treatment Design Flow Rate (Qwq)
    - Predeveloped condition = Grass Till for the entire Impervious Area
    - Postdeveloped condition = Impervious Area delineation
    - Water Quality 15-minute Design Discharge for Link Inflow – off-line facility from Water Quality Data
    - Swales considered “offline”
- Swale depth
    - 0.33 ft (HRM Table RT.04.2)
    - infrequent mowing
- Assume trapezoidal channel
    - 4:1 side slopes
- Residence time, t
    - 9 min (HRM pg 5-49)

- Flow spreaders
  - If B > 6 ft than 1 every 50 ft and 1 at inlet (HRM pg 5-56)
- Swale length, L
  - Min 100 ft
- Freeboard
  - 1 ft (HRM Table TR.04.2)
- When swales are in parallel there is a 2 ft wide divider which runs between

Constructed Wetlands:

- Post developed Cover Type
  - Impervious
- Computational Timestep
  - 1 Hour
- Water Quality Treatment Volume
  - Computed Basic Wet Pond Volume
- Compost Amended Soil Depth
  - 12 inches

Maintenance Access Roads: (HRM pgs 5-24 thru 5-25)

  - Width = 12 ft straight segments, 15 ft on curves
  - Outside turning radius = 40 ft

5.3 Flow Control/Water Quality Treatment BMPs

Water quality facility dimensions and contributing impervious areas are summarized in Table 5-1. Appendix B contains facility sizing calculations and design data for these stormwater facilities. The CIA for each facility is delineated in Appendix A.

Table 5-1. Water Quality Treatment/Flow Control Facility Summary

Sub-Basin	Facility Type/ Number	Impervious Area Collected (acres)	Pervious Area Collected (acres)	Surface Area (sq-ft)	Bottom Length/ Width (ft/ft)	Volume (cu-ft)	Depth (ft)	Bottom Elev. (ft)
CR-01/CR-02	Constructed Wetland/CR-ICP-A	11.1		37000		56000	2.5	
	Constructed Wetland/CR-ICP-B	9.9		40000		48000	2.5	
	Constructed Wetland/CR-ICP-C	8.8		25500		42000	2.5	
NPH-1	Biofiltration Swale/NPH-A	2.9			124/8		1.5	23.5
NPH-2	Constructed Wetland/NPH-B	10.5		34000		51000	2.5	26.0

Notes: Numbers may change with project design progression. Pervious surfaces will be included in the next phase of design.

5.3.1 Water Quality Facility CR-ICP-A

CR-ICP-A is designed as a constructed wetland. MGSFlood modeling provided the water quality volume of approximately 56,000 cubic feet. This volume was used with the CWS guidelines for sizing wetlands. This facility has a proposed top elevation of approximately 34.0 ft and a water surface elevation of 33.0 ft. It is approximately 335 feet long and 110 feet wide, at the top. It has 5:1 side slopes to the water quality surface level and 3:1 side slopes to the top of freeboard which is in addition to the ponds capacity for the 25-year storm event. It is anticipated a pond liner will be included in the pond design.

Runoff from approximately 11.1 acres of impervious pavement draining from I-5 structures north of Hayden Island Drive are conveyed to the CR-ICP-A constructed wetland located in area of the existing Thunderbird site adjacent the western edge of I-5 and southern edge of the Columbia River.

The existing drainage system will be modified and new stormwater pipe and inlets will be installed to collect runoff. Drop inlets will be installed to drain the elevated section of I-5 and route the runoff to CR-ICP-A. A flowsplitter will be installed upstream of the facility to route water quality flows to the facility while diverting high flows downstream. Outflows from the facility will be released to the Columbia River via an ODOT outfall.

The wetland was originally located on the east side of I-5, but proposed ground improvements do not support its construction schedule.

5.3.2 Water Quality Facility CR-ICP-B

CR-ICP-B is designed as a constructed wetland. MGSFlood modeling provided the water quality volume of approximately 48,000 cubic feet. This volume was used with the CWS guidelines for sizing wetlands. This facility has a proposed top elevation of approximately 36.0 ft and a water surface elevation of 31.0 ft. It is approximately 320 feet long and 125 feet wide at the top. It has 5:1 side slopes to the water quality surface level and 3:1 side slopes to the top of freeboard which is in addition to the ponds capacity for the 25-year storm event. It is anticipated a pond liner will be included in the pond design.

Runoff from approximately 9.9 acres of new impervious area from the I-5 mainline between the proposed location of Tomahawk Island Drive in the LPA and the Hayden Island Drive, will be conveyed to a constructed treatment wetland located along the west side of the interchange. The existing drainage system will be modified and new stormwater pipe and inlets will be installed according to the new roadway alignments and geometry.

A flowsplitter will be installed upstream of the facility to route water quality flows to the facility while diverting high flows downstream. Outflows from the facility will be released to the Columbia River via an ODOT outfall.

5.3.3 Water Quality Facility CR-ICP-C

CR-ICP-C is designed as a constructed wetland. MGSFlood modeling provided the water quality volume of approximately 42,000 cubic feet. This volume was used with the CWS guidelines for sizing wetlands. This facility has a proposed top elevation of 36.0 ft and water surface elevation of 32.5 ft. It is approximately 255 feet long and 100 feet wide, at the top. It has 5:1 side slopes to the water quality surface level and 3:1 side slopes to the top of freeboard which is in addition to the ponds capacity for the 25-year storm event. It is anticipated a pond liner will be included in the pond design.

Approximately 8.8 acres of impervious area from the I-5 southbound highpoint on North Portland Harbor to the proposed location of Tomahawk Island Drive in the LPA, and a portion of Jantzen Drive under I-5, a portion of the LRT Arterial bridge, and nearby ramps will be routed to the CR-ICP-C constructed treatment wetland. The constructed wetland will be located east of I-5 and north of the Jantzen Drive.

The existing drainage system will be modified and new stormwater pipe and inlets will be installed to collect runoff. Several drop inlets will be installed to drain the elevated section of I-5 and route the runoff to CR-ICP-C. A flowsplitter will be installed upstream of the facility to route water quality flows to the facility while diverting high flows downstream. Outflows from the facility will be released to the Columbia River via an ODOT outfall.

5.3.4 Water Quality Facility NPH-A

NPH-A is designed as a biofiltration swale. MGSFlood modeling provided the water quality flow of 0.23 cfs. This facility has a proposed top elevation of 25.0 ft and bottom elevation 23.5 ft. It is approximately 124 feet long and 8 feet wide, on average. It has 4:1 side slopes to the top of freeboard.

Due to grade limitations and the levee system, it would be difficult to convey runoff to the constructed wetland facilities from Marine Drive at the western end of construction to the new bridge over the LRT guideway. Approximately 2.9 acres of runoff from new pavement and sidewalk will drain to NPH-A biofiltration swale located on the northwestern side of Marine Drive. The existing system will no longer function and will be replaced with new stormwater pipe and inlets. A flowsplitter will be installed upstream of the facility to route water quality flows to the facility while diverting high flows downstream. Outflows from the swale will be released to North Portland Harbor at outfall NPH-01 via the existing COP stormwater system.

The location the swale has moved from the original design west to accommodate roadway features and currently is located adjacent to the new access road. Several options were developed to determine the appropriate location, which were developed following constraints from the access road location, the existing outfall, ROW, and the pedestrian bike path. Maintenance access to the swale will be from Marine Drive.

5.3.5 Water Quality Facility NPH-ICP-B

NPH-ICP-B is designed as a constructed wetland. MGSFlood modeling provided the water quality volume of 51,000 cubic feet. This volume was used with the CWS guidelines for sizing wetlands. It has 5:1 side slopes to the water quality surface level and 3:1 side slopes to the top of freeboard which is in addition to the ponds capacity for the 25-year storm event. It is anticipated a pond liner will be included in the pond design. At this time the facility design is in progress.

Runoff from approximately 10.5 acres of impervious surface from I-5 between the North Portland Harbor existing bridge highpoint and the lowpoint at Marine Drive Interchange; Marine

Drive highpoint to the new bridge over the LRT guideway; LRT-arterial bridge from the highpoint to Vancouver Way; southbound I-5 to MLK Boulevard, southbound I-5 to Marine Drive, and Hayden Island to southbound I-5 ramps.

Water quality facility NPH-ICP-B, a constructed wetland, is proposed at the south end of the new LRT-arterial bridge across North Portland Harbor adjacent to Marine Drive. The existing drainage conveyance system will be removed to accommodate the new roadway geometry. New stormwater pipe and inlets will be installed to convey runoff. The existing North Portland Harbor Bridge will no longer drain via scuppers. Outflows from the constructed wetland will be conveyed to North Portland Harbor to outfall NPH-02 via a new stormwater pipe system. The new outfall for NPH-02 will replace the existing outfall that is in conflict with the LRT arterial bridge abutment wall.

The location of NPH-ICP-B has remained the same throughout the design process, yet the size of the facility has increased significantly due to changes in runoff routed to the facilities resulting from roadway refinements. Because of alignment adjustments during the ICP design this facility was reduced in size. There is no longer a sediment basin associated with facility; instead a Vortex manhole or similar system will be put in place to pretreat stormwater entering the treatment basin.

5.3.6 Other Water Quality Facilities

Following is a summary of the proposed water quality facilities that comprise this category:

- Runoff from approximately 11.2 acres of proposed new, rebuilt and existing local streets and contiguous sidewalks within the CIA would be treated using planter strips and proprietary systems such as cartridge filters.
- Approximately 0.7 acres of future transit-oriented development has been assumed on the west side of I-5 to be on ballast and therefore not in need of treatment. Runoff from about 0.3 acres of the bike-pedestrian pathway east of the south end of the Columbia River Bridges will likely be shed to adjacent landscaped areas where it will infiltrate and/or evaporate. This path is physically separated from the street network.

5.4 Gutter Design

Limited surface and profile data is available for Hayden Island Interchange at the time this report was written. To determine conceptual level drainage and conveyance patterns general high and low points were utilized. When updated surface and profile data is available inlet spacing will be designed according to ODOT's Hydraulic Manual, Appendix D.

5.5 Sag Design

The inlet spacing design does not include Sag design for this submittal. However, inlets at sag locations will be designed according to ODOT's Hydraulic Manual, Appendix D Section 6.0.

5.6 Enclosed Drainage Design

Limited surface and profile data is available for Hayden Island Interchange at the time this report was written. To determine conceptual level drainage and conveyance patterns general high and low points were utilized. Additionally, it was assumed that the existing conveyance system would be utilized. Using general and conservative parameters, conveyance pipelines were laid out from the low points to the facility location and from the facility location to the existing downstream connection manhole. When updated surface and profile data is available the enclosed drainage systems for Hayden Island interchange will be designed according to the ODOT's Hydraulic Manual, Appendix F, Section to convey the 25-year event flows.

5.7 Culvert Design

No new, replaced, or modified culverts are proposed at this time. Any culvert design would be designed according to ODOT's Hydraulic Manual.

5.8 Ditch Design

No new, replaced, or modified ditches are proposed at this time. Any ditch design would be designed according to ODOT's Hydraulic Manual.

5.9 Downstream Analysis

See Section 4.5.

5.10 Level of Retrofit

Currently the design includes retrofitting the existing North Portland Harbor with bridge inlets to capture stormwater runoff currently draining directly in to the North Portland Harbor via existing scuppers.

6. Permits and Associated Reports

Detailed environmental analysis can be found in the Biological Assessment, available upon request. The Biological Opinion is found in Appendix H.

6.1 Permits and Approvals

A list of specific permits issued by WSDOT and ODOT for the I-5 ROW can be found in Appendix L.

6.2 Easements

At the current stage of design no additional easements to accommodate drainage or slopes are required. Though it is not currently anticipated, additional ROW may be required for construction or maintenance at the next phase of design.

6.3 Additional Reports or Studies

Additional reports and studies can be found in the appendices of the Biological Assessment.

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7. Inspection and Maintenance Summary

Continued inspection and maintenance of the permanent water quality and flow control facilities is vital to the long-term protection of receiving water bodies. While detailed procedures will be developed as part of final design and associated design reports, Appendix L contains general inspection and maintenance requirements contained in the ODOT Hydraulics Manual[11] and WSDOT HRM[12].

It is assumed that a vactor trunk will be required to provide maintenance for the water quality facilities described in this report. An access road, 12 feet wide on tangents and 15 feet wide on curves, has been placed in such a way that facility access is feasible. Biofiltration swales will be mowed to maintain the depth of grass necessary for them to provide treatment.

Manufacturers[13,14] of other proprietary facilities recommend one inspection per year and maintenance every 1-3 years for each facility. Historically, each facility would require approximately 30 minutes to remove debris and accumulated sediments, and replace necessary components. Facilities located within the LRT guideway, will require maintenance activities to be performed within a limited time period, generally during the early AM hours to avoid adversely affecting transit operations.

The project has participated in preliminary meetings with WSDOT, ODOT, and C-TRAN maintenance staff regarding maintenance of the stormwater facilities in terms of access and anticipated obstacles to meeting maintenance requirements due to site grading and access constraints. There has also been some discussion of using pedestrian bike path facilities for maintenance access for areas with few options for access from the highway.

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[11] Hydraulics Manual, Chapter 14 (Draft). Prepared by the Oregon Department of Transportation, Highway Division. 2007.

[12] Highway Runoff Manual. Prepared by Washington State Department of Transportation. Publication M31-16.01. June 2008.

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APPENDIX A

Drainage Basin Maps and Area Calculations

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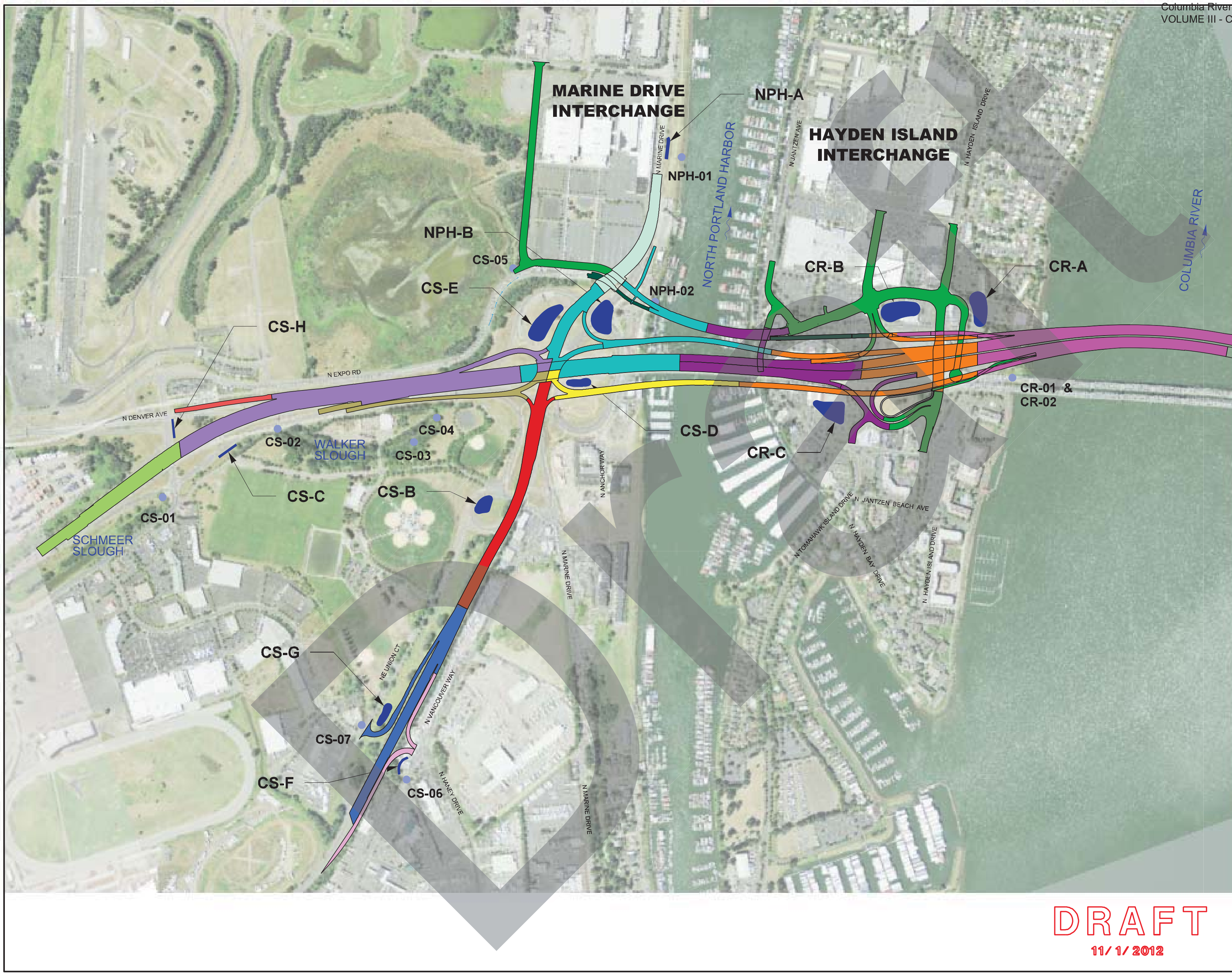

INITIAL CONSTRUCTION PROGRAM (ICP)

PROPOSED STORMWATER MANAGEMENT FACILITIES - OREGON

CONTRIBUTING IMPERVIOUS AREAS DRAINING TO WATER QUALITY TREATMENT FACILITIES

- CR-A
- CR-B
- CR-C
- CS-B
- CS-C
- CS-D
- CS-E
- CS-F
- CS-G
- CS-H
- NPH-A
- NPH-B
- LRT BALLAST TRACK
- DELTA PARK SWALE
- OTHER (PLANTER STRIPS OR PROPRIETARY SYSTEM)

STORMWATER FACILITY

- WATER QUALITY TREATMENT FACILITY
- OUTFALL

Columbia River CROSSING

INITIAL CONSTRUCTION PROGRAM (ICP)

PROPOSED STORMWATER MANAGEMENT FACILITIES - WASHINGTON STATE (1 OF 2)

CONTRIBUTING IMPERVIOUS AREAS DRAINING TO WATER QUALITY TREATMENT FACILITIES

- CR-Ca
- CR-Cc
- CR-CdCe
- CR-D
- CR-E
- CR-F
- CR-P
- OTHER (PLANTER STRIPS OR PROPRIETARY SYSTEM)

STORMWATER FACILITY

- WATER QUALITY TREATMENT FACILITY
- OUTFALL

0 200 400 600 800 1000
SCALE IN FEET

DRAFT
10/ 23/ 2012

Columbia River CROSSING

CRC_BP_DR_ShapesForExhibits_ICP.dgn 10/23/2012 5:46:22 PM

INITIAL CONSTRUCTION PROGRAM (ICP)

PROPOSED STORMWATER MANAGEMENT FACILITIES - WASHINGTON STATE (2 OF 2)

CONTRIBUTING IMPERVIOUS AREAS DRAINING TO WATER QUALITY TREATMENT FACILITIES

- CR-G
- CR-H
- CR-Lb
- CR-J
- OTHER (PLANTER STRIPS OR PROPRIETARY SYSTEM)

STORMWATER FACILITY

- WATER QUALITY TREATMENT FACILITY
- OUTFALL

0 200 400 600 800 1000
SCALE IN FEET

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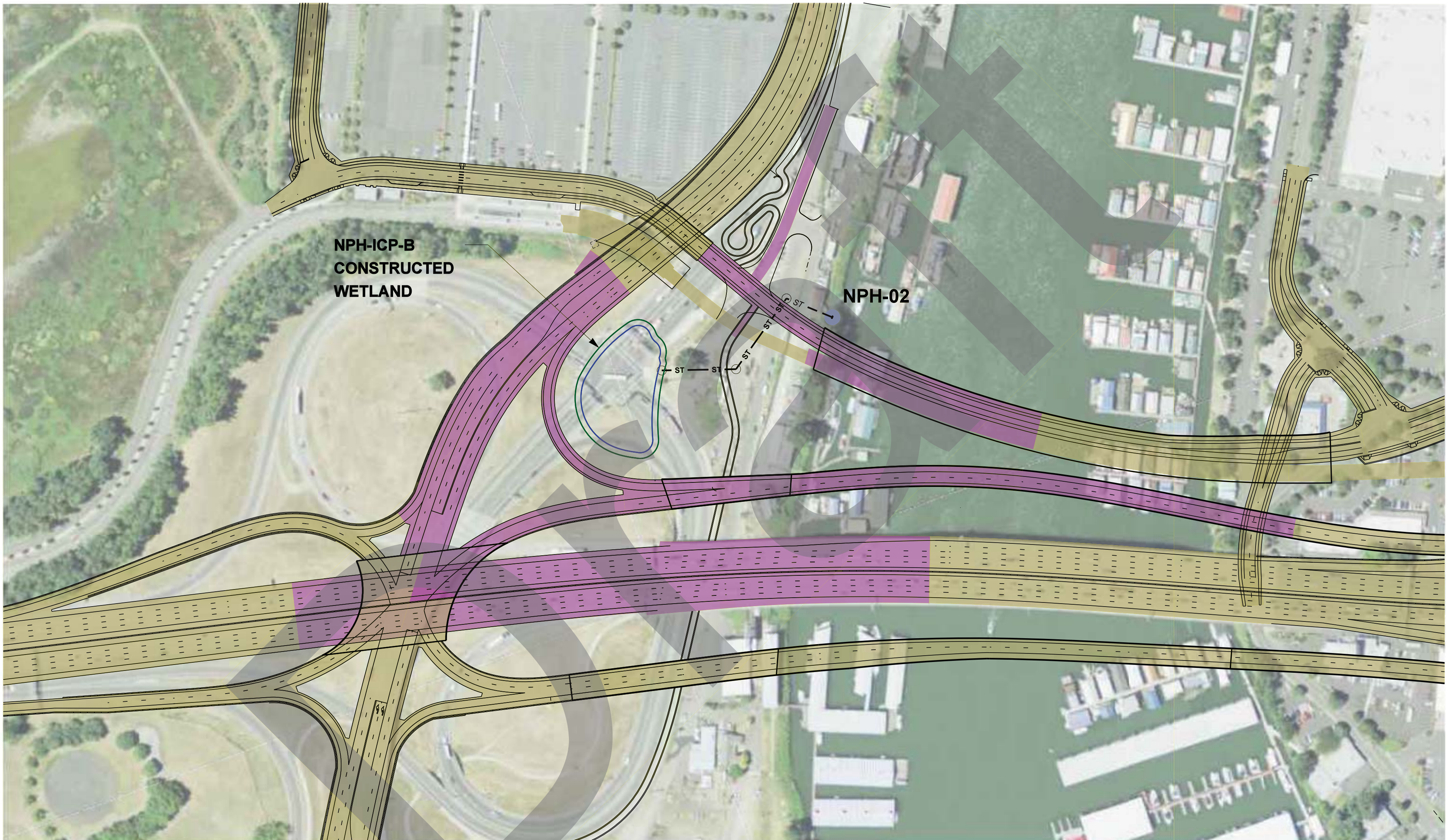
PROPOSED WATER QUALITY FACILITY NPH-A

LEGEND

- CONTRIBUTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA
- OUTFALL
- ST —— ST NEW CONVEYANCE SYSTEM
- ST — — ST EXISTING CONVEYANCE SYSTEM

Columbia River CROSSING

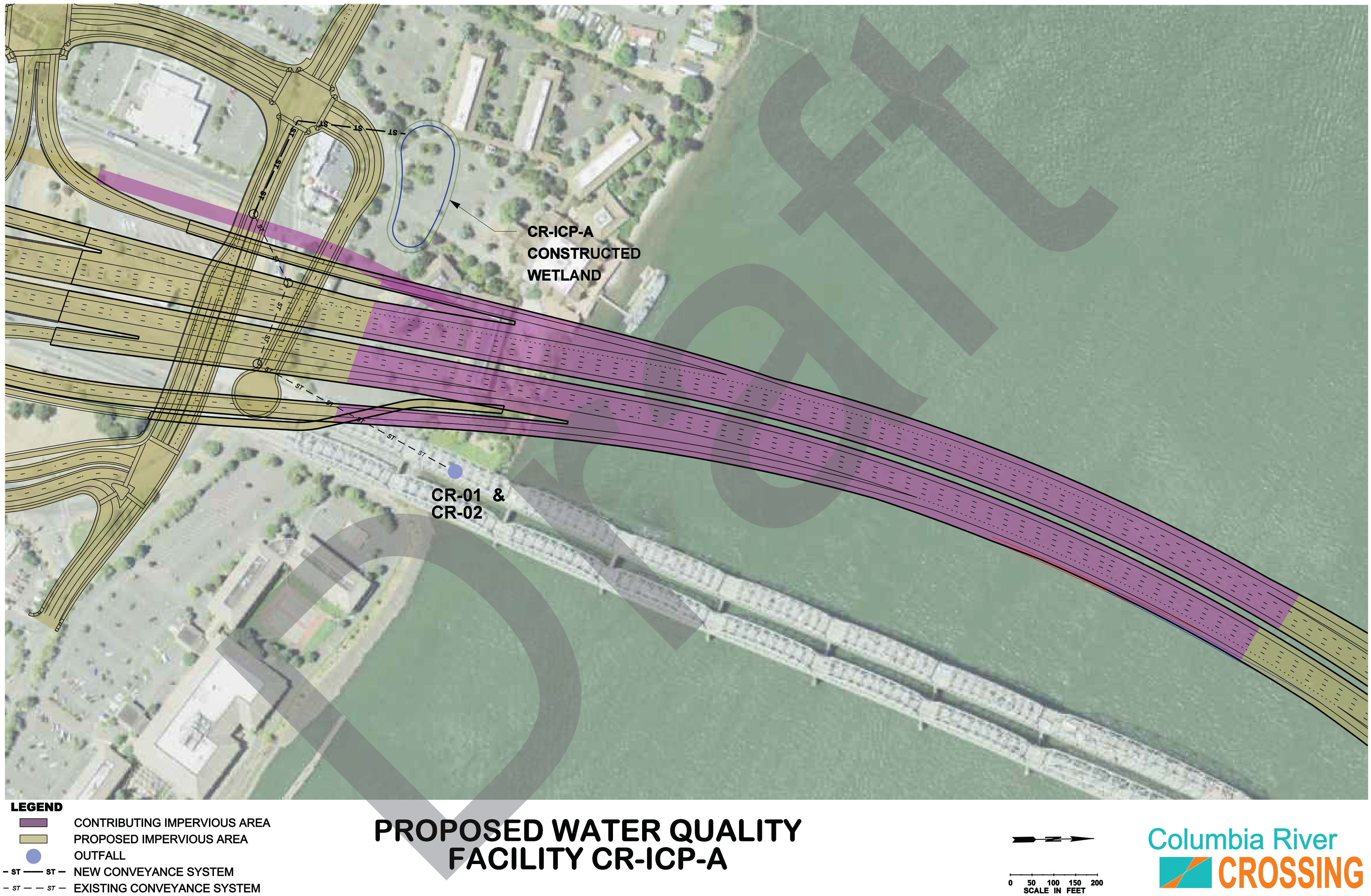


LEGEND
- CONTRIBUTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA
- OUTFALL
- ST —— ST NEW CONVEYANCE SYSTEM
- ST — — ST EXISTING CONVEYANCE SYSTEM

PROPOSED WATER QUALITY FACILITY NPH-ICP-B

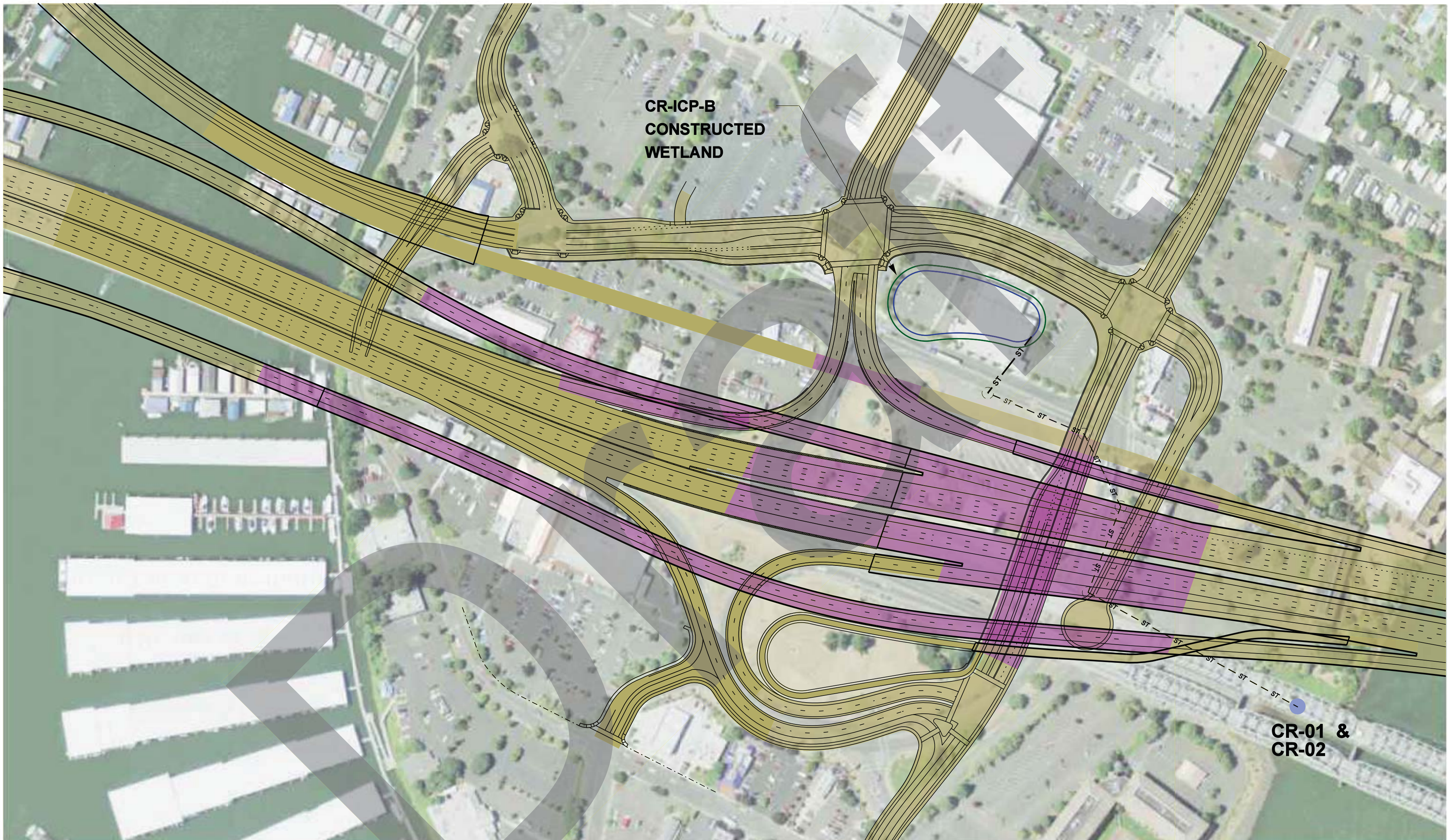
0 50 100 150 200
SCALE IN FEET

Columbia River CROSSING



PROPOSED WATER QUALITY FACILITY CR-ICP-A

PROPOSED WATER QUALITY FACILITY CR-ICP-B



LEGEND

- CONTRIBUTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA
- OUTFALL
- ST —— ST — NEW CONVEYANCE SYSTEM
- ST — — ST — EXISTING CONVEYANCE SYSTEM

Columbia River CROSSING

PROPOSED WATER QUALITY FACILITY CR-ICP-C

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APPENDIX B

Calculations and Program Output

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APPENDIX B-1

MGSFlood Output

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MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.09
Program License Number: 200210003
Run Date: 10/29/2012 11:47 AM

Input File Name: NPH-A Swale_ICP.fld
Project Name: NPH-A Swale
Analysis Title: ICP Design
Comments: Marine Drive I/C 30% Design. NPH-A Outfall, Columbia River South Watershed

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 19

Full Period of Record Available used for Routing
Precipitation Station : 97004005 Vancouver 40 in_5min 10/01/1939-10/01/2060
Evaporation Station : 971040 Vancouver 40 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) ***************

*********************** WATERSHED DEFINITION ************************

---------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 1

---------- Subbasin : Predeveloped Target Condition ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	2.900
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	2.900

---------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 1

---------- Subbasin : Post Target ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	2.900
Subbasin Total	2.900

**************************** LINK DATA *******************************

----------------------SCENARIO: PREDEVELOPED
Number of Links: 1

--
Link Name: Facility Location
Link Type: Copy
Downstream Link: None

**************************** LINK DATA *******************************

----------------------SCENARIO: POSTDEVELOPED
Number of Links: 1

--
Link Name: NPH A Biofiltration Swale
Link Type: Copy
Downstream Link: None

**********************FLOOD FREQUENCY AND DURATION STATISTICS*******************

---------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 1
Number of Links: 1

---------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 1
Number of Links: 1

*************Water Quality Facility Data ***************

---------------------SCENARIO: PREDEVELOPED

Number of Links: 1

---------------------SCENARIO: POSTDEVELOPED

Number of Links: 1

********** Link: NPH A Biofiltration Swale **********

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.41 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.23 cfs

*************Compliance Point Results ***************

Scenario Predeveloped Compliance Subbasin: Predeveloped Target Condition

Scenario Postdeveloped Compliance Subbasin: Post Target

***** Point of Compliance Flow Frequency Data *****
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.230	2-Year	1.064
5-Year	0.476	5-Year	1.425
10-Year	0.706	10-Year	1.687
25-Year	0.932	25-Year	2.134
50-Year	1.282	50-Year	2.512
100-Year	1.450	100-Year	3.005
200-Year	1.576	200-Year	3.203

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance According to Dept. of Ecology Criteria ******

Excursion at Predeveloped ½Q2 (Must be Less Than 0%): 2644.4% FAIL
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%): 11889.2% FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%): 99999.0% FAIL
Percent Excursion from Q2 to Q50 (Must be less than 50%): 100.0% FAIL

POND FAILS ONE OR MORE DURATION DESIGN CRITERIA: FAIL

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.09
Program License Number: 200210003
Run Date: 10/29/2012 12:30 PM

Input File Name: NPH-ICP-B_ICP.fld
Project Name: NPH-ICP-B Wetland
Analysis Title: ICP Design
Comments: Marine Drive I/C 30% Design Columbia River South Watershed

PRECIPITATION INPUT

Computational Time Step (Minutes): 60

Extended Precipitation Timeseries Selected
Climatic Region Number: 19

Full Period of Record Available used for Routing
Precipitation Station : 97004005 Vancouver 40 in_5min 10/01/1939-10/01/2060
Evaporation Station : 971040 Vancouver 40 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) ***************

********************** WATERSHED DEFINITION ***********************

----------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2

---------- Subbasin : Predeveloped Target Condition ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	10.500
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	10.500

---------- Subbasin : Facility Location SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.720
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	0.720

---------------------SCENARIO: POSTDEVELOPED

Number of Subbasins: 2

---------- Subbasin : Post Target ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	10.500
Subbasin Total	10.500

---------- Subbasin : NPH-ICP-B Wetland SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.720
Subbasin Total	0.720

************************ **LINK DATA** ******************************

----------------------SCENARIO: PREDEVELOPED
Number of Links: 1

--
Link Name: Facility Location
Link Type: Copy
Downstream Link: None

**************************** LINK DATA *********************************

----------------------SCENARIO: POSTDEVELOPED
Number of Links: 1

--
Link Name: NPH-ICP-B Constructed Wetland
Link Type: Copy
Downstream Link: None

*************************FLOOD FREQUENCY AND DURATION STATISTICS********************

---------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2
Number of Links: 1

---------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 2
Number of Links: 1

***********Water Quality Facility Data *************

---------------------SCENARIO: PREDEVELOPED

Number of Links: 1

********** Link: Facility Location **********

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 1776.13
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

---------------------SCENARIO: POSTDEVELOPED

Number of Links: 1

********** Link: NPH-ICP-B Constructed Wetland **********

Basic Wet Pond Volume (91% Exceedance): 50546. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 75819. cu-ft

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 3808.75
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

***********Compliance Point Results *************

Scenario Predeveloped Compliance Link: Facility Location
Scenario Postdeveloped Compliance Link: NPH-ICP-B Constructed Wetland

*** Point of Compliance Flow Frequency Data ***
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.647	2-Year	2.944
5-Year	1.135	5-Year	3.977
10-Year	1.618	10-Year	4.776
25-Year	2.261	25-Year	5.248
50-Year	2.806	50-Year	6.151
100-Year	2.851	100-Year	6.459
200-Year	2.862	200-Year	6.719

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	1164.4%	FAIL
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	6457.8%	FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	99999.0%	FAIL
Percent Excursion from Q2 to Q50 (Must be less than 50%):	100.0% FAIL	

POND FAILS ONE OR MORE DURATION DESIGN CRITERIA: FAIL

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.09
Program License Number: 200210003
Run Date: 10/31/2012 1:20 PM

Input File Name: CR-ICP-A_Wetland_ICP.fld
Project Name: CR-ICP-A
Analysis Title: ICP Design
Comments: ICP Hayden Island I/C 30% Design. CR-01/02 Outfall,

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 19

Full Period of Record Available used for Routing
Precipitation Station : 97004005 Vancouver 40 in_5min 10/01/1939-10/01/2060
Evaporation Station : 971040 Vancouver 40 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) ***************

********************** WATERSHED DEFINITION ***********************

----------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2

---------- Subbasin : Predeveloped Target Condition ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	11.100
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	11.100

---------- Subbasin : Facility Location SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.790
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	0.790

---------------------SCENARIO: POSTDEVELOPED

Number of Subbasins: 2

---------- Subbasin : Post Target ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	11.100
Subbasin Total	11.100

---------- Subbasin : CR-ICP-A Wetland SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.790
Subbasin Total	0.790

************************ **LINK DATA** *******************************

----------------------SCENARIO: PREDEVELOPED
Number of Links: 1

Link Name: Facility Location
Link Type: Copy
Downstream Link: None

**************************** LINK DATA *******************************

----------------------SCENARIO: POSTDEVELOPED
Number of Links: 1

Link Name: CR-ICP-A Constructed Wetland
Link Type: Copy
Downstream Link: None

**********************FLOOD FREQUENCY AND DURATION STATISTICS*******************

----------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2
Number of Links: 1

----------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 2
Number of Links: 1

***********Water Quality Facility Data *************

----------------------SCENARIO: PREDEVELOPED

Number of Links: 1

********** Link: Facility Location **********

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 1890.86
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

----------------------SCENARIO: POSTDEVELOPED

Number of Links: 1

********** Link: CR-ICP-A Constructed Wetland **********

Basic Wet Pond Volume (91% Exceedance): 54050. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 81075. cu-ft

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 4090.92
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

*************Compliance Point Results** *************

Scenario Predeveloped Compliance Link: Facility Location
Scenario Postdeveloped Compliance Link: CR-ICP-A Constructed Wetland

*** **Point of Compliance Flow Frequency Data** ***
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.909	2-Year	4.348
5-Year	1.931	5-Year	5.773
10-Year	2.658	10-Year	6.917
25-Year	3.822	25-Year	8.751
50-Year	5.255	50-Year	10.298
100-Year	5.946	100-Year	12.319
200-Year	6.463	200-Year	13.132

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** **Flow Duration Performance According to Dept. of Ecology Criteria** ****
Excursion at Predeveloped ½Q2 (Must be Less Than 0%): 2404.5% FAIL
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%): 11969.2% FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%): 99999.0% FAIL
Percent Excursion from Q2 to Q50 (Must be less than 50%): 100.0% FAIL

POND FAILS ONE OR MORE DURATION DESIGN CRITERIA: FAIL

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.09
Program License Number: 200210003
Run Date: 10/31/2012 1:33 PM

Input File Name: CR-ICP-B_Wetland_ICP.fld
Project Name: Constructed Wetland CR-ICP-B
Analysis Title: ICP Design
Comments: Hayden Island I/C 30% Design Columbia River South Watershed

PRECIPITATION INPUT

Computational Time Step (Minutes): 60

Extended Precipitation Timeseries Selected
Climatic Region Number: 19

Full Period of Record Available used for Routing
Precipitation Station : 97004005 Vancouver 40 in_5min 10/01/1939-10/01/2060
Evaporation Station : 971040 Vancouver 40 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) ***************

*********************** WATERSHED DEFINITION ***********************

---------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2

---------- Subbasin : Predeveloped Target Condition ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	9.900
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	9.900

---------- Subbasin : Facility Location SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.670
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	0.670

---------------------SCENARIO: POSTDEVELOPED

Number of Subbasins: 2

---------- Subbasin : Post Target ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	9.900
Subbasin Total	9.900

---------- Subbasin : CR-ICP-B Wetland SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.670
Subbasin Total	0.670

**************************** LINK DATA *******************************

----------------------SCENARIO: PREDEVELOPED
Number of Links: 1

Link Name: Facility Location
Link Type: Copy
Downstream Link: None

**************************** LINK DATA *******************************

----------------------SCENARIO: POSTDEVELOPED
Number of Links: 1

Link Name: CR-ICP-B Constructed Wetland
Link Type: Copy
Downstream Link: None

************************FLOOD FREQUENCY AND DURATION STATISTICS*********************

---------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2
Number of Links: 1

---------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 2
Number of Links: 1

*************Water Quality Facility Data ***************

---------------------SCENARIO: PREDEVELOPED

Number of Links: 1

********** Link: Facility Location **********

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 1673.24
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

---------------------SCENARIO: POSTDEVELOPED

Number of Links: 1

********** Link: CR-ICP-B Constructed Wetland **********

Basic Wet Pond Volume (91% Exceedance): 47618. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 71427. cu-ft

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 3588.10
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

***********Compliance Point Results *************

Scenario Predeveloped Compliance Link: Facility Location
Scenario Postdeveloped Compliance Link: CR-ICP-B Constructed Wetland

*** **Point of Compliance Flow Frequency Data** ***
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.609	2-Year	2.773
5-Year	1.070	5-Year	3.747
10-Year	1.525	10-Year	4.499
25-Year	2.130	25-Year	4.944
50-Year	2.643	50-Year	5.794
100-Year	2.686	100-Year	6.084
200-Year	2.696	200-Year	6.330

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** **Flow Duration Performance According to Dept. of Ecology Criteria** ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	1164.4%	FAIL
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	6457.8%	FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	99999.0%	FAIL
Percent Excursion from Q2 to Q50 (Must be less than 50%):	100.0% FAIL	

POND FAILS ONE OR MORE DURATION DESIGN CRITERIA: FAIL

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.09
Program License Number: 200210003
Run Date: 10/29/2012 3:47 PM

Input File Name: CR-C_Wetland_ICP.fld
Project Name: CR-ICP-C Constructed Wetland
Analysis Title: ICP Design
Comments: Hayden Island I/C 30% Design Columbia River South Watershed

PRECIPITATION INPUT

Computational Time Step (Minutes): 60

Extended Precipitation Timeseries Selected
Climatic Region Number: 19

Full Period of Record Available used for Routing
Precipitation Station : 97004005 Vancouver 40 in_5min 10/01/1939-10/01/2060
Evaporation Station : 971040 Vancouver 40 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) ***************

*********************** WATERSHED DEFINITION ***********************

----------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2

---------- Subbasin : Predeveloped Target Condition ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	8.800
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	8.800

---------- Subbasin : Facility Location SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.580
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000
Subbasin Total	0.580

---------------------SCENARIO: POSTDEVELOPED

Number of Subbasins: 2

---------- Subbasin : Post Construction ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	8.800
Subbasin Total	8.800

---------- Subbasin : CR-ICP-C Wetland SA ----------

	-------Area(Acres) --------
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.580
Subbasin Total	0.580

************************* **LINK DATA** *******************************

---------------------SCENARIO: PREDEVELOPED
Number of Links: 1

Link Name: Facility Location
Link Type: Copy
Downstream Link: None

************************* **LINK DATA** *******************************

---------------------SCENARIO: POSTDEVELOPED
Number of Links: 1

Link Name: CR-ICP-C Construction Wetland
Link Type: Copy
Downstream Link: None

**************************FLOOD FREQUENCY AND DURATION STATISTICS*******************

---------------------SCENARIO: PREDEVELOPED
Number of Subbasins: 2
Number of Links: 1

---------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 2
Number of Links: 1

***********Water Quality Facility Data *************

---------------------SCENARIO: PREDEVELOPED

Number of Links: 1

********** Link: Facility Location **********

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft): 1484.86
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

---------------------SCENARIO: POSTDEVELOPED

Number of Links: 1

********** Link: CR-ICP-C Construction Wetland **********

Basic Wet Pond Volume (91% Exceedance):   42257. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 63386. cu-ft

Infiltration/Filtration Statistics--------------------
Total Runoff Volume (ac-ft):   3184.14
Total Runoff Infiltrated (ac-ft):   0.00,   0.00%
Total Runoff Filtered (ac-ft):   0.00,   0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

***********Compliance Point Results *************

Scenario Predeveloped Compliance Link: Facility Location
Scenario Postdeveloped Compliance Link: CR-ICP-C Construction Wetland

*** Point of Compliance Flow Frequency Data ***
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.541	2-Year	2.461
5-Year	0.949	5-Year	3.325
10-Year	1.353	10-Year	3.993
25-Year	1.891	25-Year	4.387
50-Year	2.346	50-Year	5.142
100-Year	2.383	100-Year	5.399
200-Year	2.392	200-Year	5.617

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):   1164.4%   FAIL
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):   6457.8%   FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):   99999.0%   FAIL
Percent Excursion from Q2 to Q50 (Must be less than 50%):   100.0% FAIL

POND FAILS ONE OR MORE DURATION DESIGN CRITERIA: FAIL

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APPENDIX B-2

BMPs Design

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DESIGN WORKSHEET FOR BIOFILTRATION SWALES

PROJECT:	Columbia River Crossing	29-Oct	Prepared by: C. Sourek
BASIN:	Columbia River - South		Checked by: L.Line
OUTFALL:			
LOCATION\JURISDICTION:	ODOT		
TREATMENT FACILITY:	Biofiltration Swale(s)		
FACILITY NAME:	NPH-A		

Parameter		Units	Comments
Preliminary teps P from D o ember pg			
Impervious Area A	126,324	sq ft	
	2.90	acre	Delineated in Cad dgn file
Water Quality Design Storm Depth, P	2.09	in	2yr-24hr (45.6387° N, 122.6615° W) *[OAA Atlas 2 recipitation requency Data Output]*
Runoff Treatment Design Flow Rate, Q_{wq}	0.23	cfs	Cont. Model in MGSFlood; P-1; includes swale surface area
$P_{(72\%-2yr)}$	1.50	in	72% of the 2yr-24hr precipitation depth (6month-24hr precip can be used instead) *[H M pg. 5-]*
k	3.71		= 2.5*$P_{(72\%-2yr)}$ - 0.052 (for off-line bioswales in western WA) *[H M pg 5-]*
Biofiltration Design Flow Rate, Q_{biofil}	0.86	cfs	= k*Q_{wq}; P-2
Longitudinal Slope, s	1.5	%	Recommended 1.5-5.0%; P-3 *[H M Table T. .2]*
	0.015	ft/ft	
Manning "n"	0.35		Assuming surface roughening features, n=0.35; P-4 *[H M Table T. .1]*
Design teps D from D o ember pg t r			
Design Depth, y	4	in	Assuming infrequent mowing; D-1 *[H M Table T. .2]*
	0.33	ft	
Treatment Area side slope, z	4	:1	per WSDOT maintenance request 25Nov08, Trapezoidal channel; D-2
Cross-Sectional Area, A	3.75	sq ft	= (b + zy)*y; D-4 *[H M Table T. .5]*
Wetted Perimeter, P	12.67	ft	= b + 2y*$(1+z^2)^{0.5}$ *[H M Table T. .5]*
Hydraulic Radius, R	0.30		= A / P *[H M Table T. .5]*
= (Q_{biofil}*n) / ($1.49s^{0.5}$)	1.66		Goal Seek to = $AR^{0.67}$ by changing Q_{wq}; *[H M Equation T. -1]*
= $AR^{0.67}$	1.66		Goal Seek to = (Q_{biofil}*n) / ($1.49s^{0.5}$) by changing b; D-3, Method 1 *[H M Equation T. -1]*
Bottom Width, b	9.9	ft	
Actual Bottom Width, b	10.0	ft	2-10 ft *[H M Table T. .2]*
Residence Time, t	9.00	min	For basic biofiltration swales *[H M pg 5-]*
Velocity, V_{biofil}	0.23	fps	= Q_{biofil} / A, Max 1.0fps; D-5 *[H M Equation T. -2]*
Swale Length , L	124.4	ft	= V_{biofil} * t * 60(sec/min); D-6
Actual Swale Length, L	125.0	ft	Min 100ft [*H M Table T. .2]*
Top Width, T	12.59	ft	= B + 2yz *[H M Table. .5]*
Number of Flow Spreaders	4		If b > 6ft recommended flow spreader every 50 ft plus one at inlet *[H M pg 5-56]*
Freeboard	1.0	ft	Min 1.0ft *[H M Table T. .2]*
Total Swale Depth	1.33	ft	Freeboard plus Design Depth, y
Actual Top Width	21	ft	includes Freeboard
Actual Top Length	136	ft	includes Freeboard
Minimum Area Required	2,574	sq ft	
	0.06	acre	
Access Road Width	12.0	ft	*[igure T. .1]*
Total Area Required	4,074	sq ft	Access Road Width added to Actual Top Width - access road running parallel to swale length
	0.09	acre	
NRCS Hydrologic Soil Group	B		
Underdrain Required	NO		*[igure T. .3]*
Energy Dissipater Required	NO		*[H M-Design ite Elements pg. 5-56]*
Parallel Swales Required	NO		*[Table T. .2; comment 2]*
f parallel s ales are re ire			
Swale Width	n/a	ft	
Swale Length	n/a	ft	
Water Surface Width	n/a	ft	
Water Surface Length	n/a	ft	
Actual Top Width	n/a	ft	both swales and assuming 2ft divider width
Actual Top Length	n/a	ft	
Total Area Required	n/a	ac	

Oregon

ICP Design
NPH-ICP-B (Outfall XX)

DESIGN WORKSHEET FOR CONSTRUCTED WETLANDS

PROJECT:	Columbia River Crossing
BASIN:	Columbia River - South
OUTFALL:	
LOCATION\JURISDICTION:	ODOT
TREATMENT FACILITY:	Constructed Wetland
FACILITY NAME:	NPH-ICP-B
ORIGINAL DESIGN DATE:	7/1/2012 apprx
UPDATED:	10/29/2012
DESIGNED BY:	C. Sourek
CHECKED BY:	L. Line

Parameter		Units	Comments
Preliminary Data Collection			
Contributing Impervious Area, CIA	10.50	acres	
	457380	sq-ft	Delineated with CAD software, 10/2012
Water Quality Volume, WQV	50546	cu-ft	Calculated in MGSFlood with a 1-hour timestep (basic wet pond volume, 91% exceedance), includes facility surface area
Total Water Volume, VT	51350	cu-ft	VT = V1 + V2 + V3; should meet or exceed WQV
Uppermost Layer of Facility Dimensions			
Top of Facility			
Total Top Width, W	135	ft	Primary input
Total Top Length, L	250	ft	Primary input
Total Top Surface Area, B	33750	sq-ft	= Total Top Length * Total Top Width
Top Elevation	29.5	ft	From contours/proposed surfaces
At Water Surface			
Upland/Dry Side Slope, Z1	3	:1	maximum 3:1 *[LIDA Handbook; pg. 51]*
Freeboard Depth	1.0	ft	80% of WQV *[Low Impact Development Approaches (LIDA) Handbook; pg. 51]*
Total Water Surface Width, W1	129	ft	= Total Top Width - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Length, L1	244	ft	= Total Top Length - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Area, B1	31476	sq-ft	= W1 * L1
Total Water Surface Area	0.72	acres	
Water Surface Elevation	28.5	ft	= Top Elevation - Freeboard Depth
At Berm			
Wet Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Width	12	ft	per requirements????
Water Depth Above Berm, h1	1	ft	per requirements????
Width (approx), W2	119	ft	= W1 - (2 * Z3 * h1)
Length (approx), L2	234	ft	= L1 - (2 * Z3 * h1)
Surface Area, B2	27846	sq-ft	= L1 * W1
Berm Elevation	28	ft	= Top Elevation - Freeboard Depth
Overall			
Volume of Water Above the Berm, V1	29642	cu-ft	frustum volume = (h/3) * (B1 + B2 + √B2*B1) *[ODOT Hydraulics Manual; Equation 12-16]*
Amended Soils Depth	1	ft	12 inch minimum *[LIDA Handbook; pg. 53]*
Forebay Design			
Ideal Forebay Volume	10109	cu-ft	20% of WQV [Low Impact Development Approaches (LIDA) Handbook; pg. 51]
Actual Forebay Volume, VF	10020	cu-ft	= V2 + % of V1 as determine by (L2f + 1/2 of berm width) / L2; Should meet or exceed Ideal Forebay Volume
Calculated Volume, V2	5206	cu-ft	frustum volume = (h2/3) * (B2f + B3f + √B2fB3f); does not include volume above the berm *[ODOT Hydraulics Manual; Equation 12-16]*
At Water Surface			
Forebay Water Surface Width, W1f	129	ft	= W1
Forebay Water Surface Length, L1f	40	ft	=Whatever makes L3f min of 4 ft OR {= 0.1 * L1}; Use goal seek to determine by setting L3f to 4; Adjust to obtain desired relative volumes
Forebay Water Surface Area, B1f	3148	sq-ft	10% of Total Surface Area *[LIDA Handbook; pg. 51]*
At Berm			
Width (approx), W2f	119	ft	= W2
Length (approx), L2f	29	ft	= L2 - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2f	3451	sq-ft	= W2f * L2f
Pond Bottom			
Depth Below Berm, h2	3	ft	
Forebay Side Slope, Z2	4	:1	H:V
Berm Side Slope, Zbf	4	:1	H:V
Elevation	25	ft	= Berm Elevation - h2
Width (approx), W3f	95	ft	= W2 - (2 * Z3 * h2)
Length (approx), L3f	5	ft	= L2f - (Z3 * h2) - (Z2f * h2); Min 4 ft; Use Goal Seek to determine by changing L1f
Bottom Area, B3f	475	sq-ft	= W3f * L3f
Permenant Pool Design			
Calculated Volume, V3	16502	cu-ft	V3 = 2Va + Vb + Vc + 2Vd (see notes)
At Water Surface			
Pool Water Surface Width, W1p	129	ft	= W1
Pool Water Surface Length, L1p	204	ft	= L1 - L1f OR {= 0.9 * L1}
At Berm			
Width (approx), W2p	119	ft	= W2
Length (approx), L2p	193	ft	= L1p - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2p	22967	sq-ft	= W2p * L2p
Pond Bottom			
Max Depth Below Berm, h3	1.5	ft	maximum 2.5 ft *[LIDA Handbook; pg. 52]*
Pool Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Side Slope, Zbp	5	:1	H:V
Elevation	26.0	ft	= Berm Elevation - h3
Width (approx), W3p	104	ft	= W2p - (2 * Z3 * h3)
Length (approx), L3p	178	ft	= L2p - (Z3 * h3) - (Zbp * h3)
Bottom Area, B3	18512	sq-ft	= W3p * L3p
Volumes - Permenant Pool volumes were calculated assuming a sloped bottom (from the berm top to the pool bottom). The volume was modeled and calculated by slicing the pool into 6 simpler shapes. The volumes for those shapes were calculated and combined to determine overall volume. This is an assumption. Actual pool volume will depend on contours and pooling areas within the main pool.			
Va	696	cu-ft	Pyramid, V = {(1/3) * Z3 * h3^2} * (L2p - Z3*h3)
Vb	14469	cu-ft	Prism, V = (1/2) * h3 * (L2p - Z3*h3) * (W2p - 2*Z3*h3)
Vc	585	cu-ft	Prism, V = Z3 * h3^2 * {(1/2)*W2p - Z3*h3}
Vd	28	cu-ft	Pyramid, V = {(1/3) * Z3^2 * h3^3}

Notes:

(yellow)	Denotes input required
(blue)	Goal Seek to Determine Values
(green)	Match equations to Forebay WS Length, L1f, if necessary

Geometry per Cleanwater Services recommendations
Sizing parameters per ???? ODOT???? CRC ???

Oregon

ICP Design
CR-ICP-A (Outfall XX)

DESIGN WORKSHEET FOR CONSTRUCTED WETLANDS

PROJECT:	Columbia River Crossing
BASIN:	Columbia River - South
OUTFALL:	
LOCATION\JURISDICTION:	ODOT
TREATMENT FACILITY:	Constructed Wetland
FACILITY NAME:	CR-ICP-A
ORIGINAL DESIGN DATE:	8/13/2012
UPDATED:	10/31/2012
DESIGNED BY:	C. Sourek
CHECKED BY:	L. Line

Parameter		Units	Comments
Preliminary Data Collection			
Contributing Impervious Area, CIA	11.10	acres	
	483516	sq-ft	Delineated with CAD software, 10/2012
Water Quality Volume, WQV	54050	cu-ft	Calculated in MGSFlood with a 1-hour timestep (basic wet pond volume, 91% exceedance), includes facility surface area
Total Water Volume, VT	56645	cu-ft	VT = V1 + V2 + V3; should meet or exceed WQV
Uppermost Layer of Facility Dimensions			
Top of Facility			
Total Top Width, W	110	ft	Primary input
Total Top Length, L	335	ft	Primary input
Total Top Surface Area, B	36850	sq-ft	= Total Top Length * Total Top Width
Top Elevation	34	ft	From contours/proposed surfaces
At Water Surface			
Upland/Dry Side Slope, Z1	3	:1	maximum 3:1 *[LIDA Handbook; pg. 51]*
Freeboard Depth	1	ft	80% of WQV *[Low Impact Development Approaches (LIDA) Handbook; pg. 51]*
Total Water Surface Width, W1	104	ft	= Total Top Width - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Length, L1	329	ft	= Total Top Length - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Area, B1	34216	sq-ft	= W1 * L1
Total Water Surface Area	0.79	acres	
Water Surface Elevation	33	ft	= Top Elevation - Freeboard Depth
At Berm			
Wet Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Width	12	ft	per requirements????
Water Depth Above Berm, h1	1	ft	per requirements????
Width (approx), W2	94	ft	= W1 - (2 * Z3 * h1)
Length (approx), L2	319	ft	= L1 - (2 * Z3 * h1)
Surface Area, B2	29986	sq-ft	= L1 * W1
Berm Elevation	32	ft	= Top Elevation - Freeboard Depth
Overall			
Volume of Water Above the Berm, V1	32078	cu-ft	frustum volume = (h/3) * (B1 + B2 + vB2*B1) *[ODOT Hydraulics Manual; Equation 12-16]*
Amended Soils Depth	1	ft	12 inch minimum *[LIDA Handbook; pg. 53]*
Forebay Design			
Ideal Forebay Volume	10810	cu-ft	20% of WQV [Low Impact Development Approaches (LIDA) Handbook; pg. 51]
Actual Forebay Volume, VF	11505	cu-ft	= V2 + % of V1 as determine by (L2f + 1/2 of berm width) / L2; Should meet or exceed Ideal Forebay Volume
Calculated Volume, V2	6678	cu-ft	frustum volume = (h2/3) * (B2f + B3f + vB2fB3f); does not include volume above the berm *[ODOT Hydraulics Manual; Equation 12-16]*
At Water Surface			
Forebay Water Surface Width, W1f	104	ft	= W1
Forebay Water Surface Length, L1f	50	ft	=Whatever makes L3f min of 4 ft OR {= 0.1 * L1}; Use goal seek to determine by setting L3f to 4; Adjust to obtain desired relative volumes
Forebay Water Surface Area, B1f	3422	sq-ft	10% of Total Surface Area *[LIDA Handbook; pg. 51]*
At Berm			
Width (approx), W2f	94	ft	= W2
Length (approx), L2f	39	ft	= L2 - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2f	3666	sq-ft	= W2f * L2f
Pond Bottom			
Depth Below Berm, h2	3	ft	
Forebay Side Slope, Z2	4	:1	H:V
Berm Side Slope, Zbf	4	:1	H:V
Elevation	29	ft	= Berm Elevation - h2
Width (approx), W3f	70	ft	= W2 - (2 * Z3 * h2)
Length (approx), L3f	15	ft	= L2f - (Z3 * h2) - (Z2f * h2); Min 4 ft; Use Goal Seek to determine by changing L1f
Bottom Area, B3f	1050	sq-ft	= W3f * L3f
Permenant Pool Design			
Calculated Volume, V3	17889	cu-ft	V3 = 2Va + Vb + Vc + 2Vd (see notes)
At Water Surface			
Pool Water Surface Width, W1p	104	ft	= W1
Pool Water Surface Length, L1p	279	ft	= L1 - L1f OR {= 0.9 * L1}
At Berm			
Width (approx), W2p	94	ft	= W2
Length (approx), L2p	268	ft	= L1p - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2p	25192	sq-ft	= W2p * L2p
Pond Bottom			
Max Depth Below Berm, h3	1.5	ft	maximum 2.5 ft *[LIDA Handbook; pg. 52]*
Pool Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Side Slope, Zbp	5	:1	H:V
Elevation	30.5	ft	= Berm Elevation - h3
Width (approx), W3p	79	ft	= W2p - (2 * Z3 * h3)
Length (approx), L3p	253	ft	= L2p - (Z3 * h3) - (Zbp * h3)
Bottom Area, B3	19987	sq-ft	= W3p * L3p
Volumes - Permenant Pool volumes were calculated assuming a sloped bottom (from the berm top to the pool bottom). The volume was modeled and calculated by slicing the pool into 6 simpler shapes. The volumes for those shapes were calculated and combined to determine overall volume. This is an assumption. Actual pool volume will depend on contours and pooling areas within the main pool.			
Va	977	cu-ft	Pyramid, $V = \{(1/3) * Z3 * h3^2\} * (L2p - Z3*h3)$
Vb	15435	cu-ft	Prism, V = (1/2) * h3 * (L2p - Z3*h3) * (W2p - 2*Z3*h3)
Vc	444	cu-ft	Prism, $V = Z3 * h3^2 * \{(1/2)*W2p - Z3*h3\}$
Vd	28	cu-ft	Pyramid, $V = \{(1/3) * Z3^2 * h3^3\}$

Notes:

(yellow)	Denotes input required
(blue)	Goal Seek to Determine Values
(green)	Match equations to Forebay WS Length, L1f, if necessary

Geometry per Cleanwater Services recommendations
Sizing parameters per ???? ODOT???? CRC ???

Oregon

ICP Design
CR-ICP-B (Outfall XX)

DESIGN WORKSHEET FOR CONSTRUCTED WETLANDS

PROJECT: Columbia River Crossing
BASIN: Columbia River - South
OUTFALL:
LOCATION\JURISDICTION: ODOT
TREATMENT FACILITY: Constructed Wetland
FACILITY NAME: CR-ICP-B
ORIGINAL DESIGN DATE: 10/2/2012
UPDATED: 10/31/2012
DESIGNED BY: C. Sourek
CHECKED BY: L. Line

Parameter		Units	Comments
Preliminary Data Collection			
Contributing Impervious Area, CIA	9.90	acres	
	431244	sq-ft	Delineated with CAD software, 10/2012
Water Quality Volume, WQV	47618	cu-ft	Calculated in MGSFlood with a 1-hour timestep (basic wet pond volume, 91% exceedance), includes facility surface area
Total Water Volume, VT	47779	cu-ft	VT = V1 + V2 + V3; should meet or exceed WQV
Uppermost Layer of Facility Dimensions			
Top of Facility			
Total Top Width, W	175	ft	Primary input
Total Top Length, L	230	ft	Primary input
Total Top Surface Area, B	40250	sq-ft	= Total Top Length * Total Top Width
Top Elevation	36	ft	From contours/proposed surfaces
At Water Surface			
Upland/Dry Side Slope, Z1	3	:1	maximum 3:1 *[LIDA Handbook; pg. 51]*
Freeboard Depth	5	ft	80% of WQV *[Low Impact Development Approaches (LIDA) Handbook; pg. 51]*
Total Water Surface Width, W1	145	ft	= Total Top Width - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Length, L1	200	ft	= Total Top Length - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Area, B1	29000	sq-ft	= W1 * L1
Total Water Surface Area	0.67	acres	
Water Surface Elevation	31	ft	= Top Elevation - Freeboard Depth
At Berm			
Wet Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Width	12	ft	per requirements????
Water Depth Above Berm, h1	1	ft	per requirements????
Width (approx), W2	135	ft	= W1 - (2 * Z3 * h1)
Length (approx), L2	190	ft	= L1 - (2 * Z3 * h1)
Surface Area, B2	25650	sq-ft	= L1 * W1
Berm Elevation	30	ft	= Top Elevation - Freeboard Depth
Overall			
Volume of Water Above the Berm, V1	27308	cu-ft	frustum volume = (h/3) * (B1 + B2 + vB2*B1) *[ODOT Hydraulics Manual; Equation 12-16]*
Amended Soils Depth	1	ft	12 inch minimum *[LIDA Handbook; pg. 53]*
Forebay Design			
Ideal Forebay Volume	9524	cu-ft	20% of WQV [Low Impact Development Approaches (LIDA) Handbook; pg. 51]
Actual Forebay Volume, VF	11406	cu-ft	= V2 + % of V1 as determine by (L2f + 1/2 of berm width) / L2; Should meet or exceed Ideal Forebay Volume
Calculated Volume, V2	5944	cu-ft	frustum volume = (h2/3) * (B2f + B3f + vB2fB3f); does not include volume above the berm *[ODOT Hydraulics Manual; Equation 12-16]*
At Water Surface			
Forebay Water Surface Width, W1f	145	ft	= W1
Forebay Water Surface Length, L1f	40	ft	=Whatever makes L3f min of 4 ft OR {= 0.1 * L1}; Use goal seek to determine by setting L3f to 4; Adjust to obtain desired relative volumes
Forebay Water Surface Area, B1f	2900	sq-ft	10% of Total Surface Area *[LIDA Handbook; pg. 51]*
At Berm			
Width (approx), W2f	135	ft	= W2
Length (approx), L2f	29	ft	= L2 - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2f	3915	sq-ft	= W2f * L2f
Pond Bottom			
Depth Below Berm, h2	3	ft	
Forebay Side Slope, Z2	4	:1	H:V
Berm Side Slope, Zbf	4	:1	H:V
Elevation	27	ft	= Berm Elevation - h2
Width (approx), W3f	111	ft	= W2 - (2 * Z3 * h2)
Length (approx), L3f	5	ft	= L2f - (Z3 * h2) - (Z2f * h2); Min 4 ft; Use Goal Seek to determine by changing L1f
Bottom Area, B3f	555	sq-ft	= W3f * L3f
Permenant Pool Design			
Calculated Volume, V3	14528	cu-ft	V3 = 2Va + Vb + Vc + 2Vd (see notes)
At Water Surface			
Pool Water Surface Width, W1p	145	ft	= W1
Pool Water Surface Length, L1p	160	ft	= L1 - L1f OR {= 0.9 * L1}
At Berm			
Width (approx), W2p	135	ft	= W2
Length (approx), L2p	149	ft	= L1p - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2p	20115	sq-ft	= W2p * L2p
Pond Bottom			
Max Depth Below Berm, h3	1.5	ft	maximum 2.5 ft *[LIDA Handbook; pg. 52]*
Pool Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Side Slope, Zbp	5	:1	H:V
Elevation	28.5	ft	= Berm Elevation - h3
Width (approx), W3p	120	ft	= W2p - (2 * Z3 * h3)
Length (approx), L3p	134	ft	= L2p - (Z3 * h3) - (Zbp * h3)
Bottom Area, B3	16080	sq-ft	= W3p * L3p
Volumes - Permenant Pool volumes were calculated assuming a sloped bottom (from the berm top to the pool bottom). The volume was modeled and calculated by slicing the pool into 6 simpler shapes. The volumes for those shapes were calculated and combined to determine overall volume. This is an assumption. Actual pool volume will depend on contours and pooling areas within the main pool.			
Va	531	cu-ft	Pyramid, V = {(1/3) * Z3 * $h3^2$} * (L2p - Z3*h3)
Vb	12735	cu-ft	Prism, V = (1/2) * h3 * (L2p - Z3*h3) * (W2p - 2*Z3*h3)
Vc	675	cu-ft	Prism, V = Z3 * $h3^2$ * {(1/2)*W2p - Z3*h3}
Vd	28	cu-ft	Pyramid, V = {(1/3) * $Z3^2$ * $h3^3$}

Notes:

(yellow)	Denotes input required
(blue)	Goal Seek to Determine Values
(green)	Match equations to Forebay WS Length, L1f, if necessary

Geometry per Cleanwater Services recommendations
Sizing parameters per ???? ODOT???? CRC ???

Oregon

ICP Design
CR-ICP-C (Outfall XX)

DESIGN WORKSHEET FOR CONSTRUCTED WETLANDS

PROJECT:	Columbia River Crossing
BASIN:	Columbia River - South
OUTFALL:	
LOCATION\JURISDICTION:	ODOT
TREATMENT FACILITY:	Constructed Wetland
FACILITY NAME:	CR-ICP-C
ORIGINAL DESIGN DATE:	10/2/2012
UPDATED:	10/29/2012
DESIGNED BY:	C. Sourek
CHECKED BY:	L. Line

Parameter		Units	Comments
Preliminary Data Collection			
Contributing Impervious Area, CIA	8.80	acres	
	383328	sq-ft	Delineated with CAD software, 10/2012
Water Quality Volume, WQV	42257	cu-ft	Calculated in MGSFlood with a 1-hour timestep (basic wet pond volume, 91% exceedance), includes facility surface area
Total Water Volume, VT	42488	cu-ft	VT = V1 + V2 + V3; should meet or exceed WQV
Uppermost Layer of Facility Dimensions			
Top of Facility			
Total Top Width, W	140	ft	Primary input
Total Top Length, L	235	ft	Primary input
Total Top Surface Area, B	32900	sq-ft	= Total Top Length * Total Top Width
Top Elevation	36	ft	From contours/proposed surfaces
At Water Surface			
Upland/Dry Side Slope, Z1	3	:1	maximum 3:1 *[LIDA Handbook; pg. 51]*
Freeboard Depth	3.5	ft	80% of WQV *[Low Impact Development Approaches (LIDA) Handbook; pg. 51]*
Total Water Surface Width, W1	119	ft	= Total Top Width - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Length, L1	214	ft	= Total Top Length - (2 * Upland Side Slope * Freeboard Depth)
Total Water Surface Area, B1	25466	sq-ft	= W1 * L1
Total Water Surface Area	0.58	acres	
Water Surface Elevation	32.5	ft	= Top Elevation - Freeboard Depth
At Berm			
Wet Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Width	12	ft	per requirements????
Water Depth Above Berm, h1	1	ft	per requirements????
Width (approx), W2	109	ft	= W1 - (2 * Z3 * h1)
Length (approx), L2	204	ft	= L1 - (2 * Z3 * h1)
Surface Area, B2	22236	sq-ft	= L1 * W1
Berm Elevation	32	ft	= Top Elevation - Freeboard Depth
Overall			
Volume of Water Above the Berm, V1	23833	cu-ft	frustum volume = (h/3) * (B1 + B2 + √B2*B1) *[ODOT Hydraulics Manual; Equation 12-16]*
Amended Soils Depth	1	ft	12 inch minimum *[LIDA Handbook; pg. 53]*
Forebay Design			
Ideal Forebay Volume	8451	cu-ft	20% of WQV [Low Impact Development Approaches (LIDA) Handbook; pg. 51]
Actual Forebay Volume, VF	11354	cu-ft	= V2 + % of V1 as determine by (L2f + 1/2 of berm width) / L2; Should meet or exceed Ideal Forebay Volume
Calculated Volume, V2	6331	cu-ft	frustum volume = (h2/3) * (B2f + B3f + √B2fB3f); does not include volume above the berm *[ODOT Hydraulics Manual; Equation 12-16]*
At Water Surface			
Forebay Water Surface Width, W1f	119	ft	= W1
Forebay Water Surface Length, L1f	45	ft	=Whatever makes L3f min of 4 ft OR {= 0.1 * L1}; Use goal seek to determine by setting L3f to 4; Adjust to obtain desired relative volumes
Forebay Water Surface Area, B1f	2547	sq-ft	10% of Total Surface Area *[LIDA Handbook; pg. 51]*
At Berm			
Width (approx), W2f	109	ft	= W2
Length (approx), L2f	34	ft	= L2 - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2f	3706	sq-ft	= W2f * L2f
Pond Bottom			
Depth Below Berm, h2	3	ft	
Forebay Side Slope, Z2	4	:1	H:V
Berm Side Slope, Zbf	4	:1	H:V
Elevation	29	ft	= Berm Elevation - h2
Width (approx), W3f	85	ft	= W2 - (2 * Z3 * h2)
Length (approx), L3f	10	ft	= L2f - (Z3 * h2) - (Z2f * h2); Min 4 ft; Use Goal Seek to determine by changing L1f
Bottom Area, B3f	850	sq-ft	= W3f * L3f
Permenant Pool Design			
Calculated Volume, V3	12324	cu-ft	V3 = 2Va + Vb + Vc + 2Vd (see notes)
At Water Surface			
Pool Water Surface Width, W1p	119	ft	= W1
Pool Water Surface Length, L1p	169	ft	= L1 - L1f OR {= 0.9 * L1}
At Berm			
Width (approx), W2p	109	ft	= W2
Length (approx), L2p	158	ft	= L1p - (Z1 * h1) - (0.5 * Berm Width)
Surface Area at Berm, B2p	17222	sq-ft	= W2p * L2p
Pond Bottom			
Max Depth Below Berm, h3	1.5	ft	maximum 2.5 ft *[LIDA Handbook; pg. 52]*
Pool Side Slope, Z3	5	:1	maximum 5:1 *[LIDA Handbook; pg. 51]*
Berm Side Slope, Zbp	5	:1	H:V
Elevation	30.0	ft	= Berm Elevation - h3
Width (approx), W3p	94	ft	= W2p - (2 * Z3 * h3)
Length (approx), L3p	143	ft	= L2p - (Z3 * h3) - (Zbp * h3)
Bottom Area, B3	13442	sq-ft	= W3p * L3p
Volumes - Permenant Pool volumes were calculated assuming a sloped bottom (from the berm top to the pool bottom). The volume was modeled and calculated by slicing the pool into 6 simpler shapes. The volumes for those shapes were calculated and combined to determine overall volume. This is an assumption. Actual pool volume will depend on contours and pooling areas within the main pool.			
Va	564	cu-ft	Pyramid, $V = \{(1/3) * Z3 * h3^2\} * (L2p - Z3*h3)$
Vb	10610	cu-ft	Prism, V = (1/2) * h3 * (L2p - Z3*h3) * (W2p - 2*Z3*h3)
Vc	529	cu-ft	Prism, $V = Z3 * h3^2 * \{(1/2)*W2p - Z3*h3\}$
Vd	28	cu-ft	Pyramid, $V = \{(1/3) * Z3^2 * h3^3\}$

Notes:

(yellow)	Denotes input required
(blue)	Goal Seek to Determine Values
(green)	Match equations to Forebay WS Length, L1f, if necessary

Geometry per Cleanwater Services recommendations
Sizing parameters per ???? ODOT???? CRC ???

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APPENDIX B-3

Inlet Spreadsheets

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APPENDIX B-4

Sag Design Spreadsheets
(Not included with this submittal)

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APPENDIX B-5

Storm Drain Design

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PROJECT:	Columbia River Crossing
BASIN:	Columbia River - South
LOCATION:	Oregon
ORIGINAL DESIGN DATE:	11/5/2012
UPDATED:	
DESIGNED BY:	C. Sourek
CHECKED BY:	L. Line

Facility/Outlet			Pipe			Outfall/Ex Manhole					Comments
Name	Type	Water Surface Elevation	Length	Slope	Minimum Downstream Invert Elevation	Structure Identifier	Rim Elevation	Upstream Invert Elevation	Downstream Invert Elevation	Will It Drain?	
NPH-A	Biofiltration Swale	25.0	90	0.005	24.55	7744	28.6	23.6	22.9	Yes	
NPH-B	Constructed Wetland	28.5			28.5					Yes	No survey available for existing outfall; New outfall to be designed
CR-ICP-A	Constructed Wetland	33.0	450	0.005	30.75	6004	36.2	28.0	24.7	Yes	
CR-ICP-B	Constructed Wetland	31.0	180	0.005	30.1	6002	35.6	30.6	26.1	Yes	
CR-ICP-C	Constructed Wetland	32.5	190	0.005	31.55	6074	40.3	31.8	31.5	Yes	

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APPENDIX B-6

Ditch Design
(Not included with this submittal)

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APPENDIX B-7

Downstream Analysis
(Not included with this submittal)

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APPENDIX C

Drainage Plan Sheets and Details
(Not included with this submittal)

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APPENDIX D

Drainage Profile Sheets
(Not included with this submittal)

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APPENDIX E

Roadway Cross Sections and Profiles
(Not included with this submittal)

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APPENDIX F

Miscellaneous Contract Plan Sheets
(Not included with this submittal)

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APPENDIX G

Traffic Analysis Data

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The average weekday traffic across the I-5 crossing for the design year of 2030 is expected to be 178,500 vehicles. This is lower than the 184,000 daily vehicle trips predicted under a no-build scenario because of the introduction of high-capacity transit and a toll on the I-5 crossing.

1.1.1 Local Street Performance

Local street traffic performance is monitored and measured by the Cities of Portland and Vancouver, WSDOT, and ODOT based on the established performance standards for the facilities under their respective jurisdictions. Local street congestion is most intense near the I-5 ramps and is influenced by the travel direction and length of time that I-5 is congested during each weekday.

1.1.2 Vancouver

Morning Peak Hour

During the morning peak, eastbound and westbound traffic west of I-5 would increase between 10 and 20 percent over No-Build conditions. With the LPA, eastbound and westbound traffic east of I-5 would increase by up to five percent over No-Build conditions. Under the LPA with highway phasing, eastbound traffic east of I-5 would increase by approximately 30 percent and westbound traffic east of I-5 would remain relatively unchanged. The difference in eastbound traffic between the LPA and LPA with highway phasing would be due to the addition of the direct connect ramp from southbound I-5 to eastbound SR 500. Without the direct connect ramp, eastbound traffic would remain on 39th Street to access SR 500.

During the morning peak, southbound traffic in Vancouver would decrease between 10 and 35 percent along most major streets with the exception of the downtown area. Southbound traffic in downtown is expected to increase over the No-Build by approximately 10 percent. The decrease in southbound traffic on local streets would be caused by the improvements to I-5, which would encourage through traffic that has been observed to divert to arterial streets due to congestion on I-5 to return to I-5.

Northbound traffic south of Fourth Plain Boulevard would increase between five and 20 percent. Northbound traffic north of 39th Street would increase by approximately 80 percent (450 vehicles) compared to No-Build conditions. This would occur due to the closure of the 39th Street on-ramp to I-5 northbound; vehicles would use the arterial street network to access the northbound I-5 on-ramp at Main Street.

Afternoon/Evening Peak Hour

During the afternoon/evening peak, traffic volumes along key east-west local streets west of I-5 would remain unchanged and/or increase by approximately 20 percent over No-Build conditions as shown in Exhibit 7-25. Under the LPA, westbound traffic just east of I-5 would increase by approximately 15 percent and eastbound traffic just east of I-5 would decrease by approximately 25 percent compared to No-Build conditions. Under LPA with highway phasing, eastbound traffic would decrease by approximately 10 percent. The difference in eastbound traffic between the LPA and LPA with highway phasing would be due to the addition of the direct-connection ramp from southbound I-5 to eastbound SR 500. Without the direct-connection ramp, eastbound traffic would remain on 39th Street to access SR 500.

During the afternoon/evening peak hour, southbound traffic in Vancouver, depending on location, would remain unchanged or could increase up to 20 percent. Under the LPA, the southbound off-ramp to 39th Street would be removed and replaced with the new southbound SR 500 off-ramp, which would cause traffic to shift from southbound I-5 to southbound Main Street to access the neighborhood.

Northbound traffic in Vancouver would decrease between five and 30 percent relative to No-Build conditions, with the highest decrease north of the Fourth Plain interchange area.

1.1.3 Portland

Morning Peak Hour

During the morning peak, westbound traffic on both sides of the highway would decrease less than 10 percent compared to No-Build conditions as shown in Exhibit 7-26. Eastbound traffic on both sides of I-5 would increase up to 10 percent, with the higher growth forecast for the eastside of I-5.

During the morning peak, southbound traffic in Portland would decrease by up to five percent over No-Build conditions. Northbound traffic in Portland would remain unchanged or decrease between 10 and 20 percent compared to No-Build conditions.

Afternoon/Evening Peak Hour

During the afternoon/evening peak, eastbound and westbound traffic on both sides of the highway would change by less than 10 percent compared to No-Build conditions as shown in Exhibit 7-27. Northbound and southbound traffic in Portland would change by less than 10 percent during the afternoon/evening peak hour.

1.1.4 Average Daily Traffic

Average daily traffic (ADT) is the average number of vehicles passing a specific point in a 24-hour period, normally measured throughout a year. ADT is the standard measurement for vehicle traffic load on a section of road, and the basis for most decisions regarding transport planning, or to the environmental hazards of pollution related to road transport. For the CRC project, the region-wide impacts to numerous intersections and interchanges have been projected for 2030. These data are based on the design of the Locally Preferred Alternative and the assumption that I-5 will be tolled in the corridor. Using regional travel-demand models and micro-simulation traffic modeling, the following ADTs have been projected for the LPA.

SOUTHBOUND Location	2030 ADT Volumes	NORTHBOUND Location	2030 ADT Volumes
I-5 Mainline North of Main St.	79,255	I-5 Mainline South of Columbia Blvd. ON	69,385
Main St. OFF	14,780	Columbia Blvd. OFF	6,875
I-5 Mainline	64,475	I-5 Mainline	62,510
Main St. ON	8,710	Victory Blvd. OFF	3,540
I-5 Mainline	73,185	I-5 Mainline	58,970
SR-500/39th St. OFF	0	Marine Dr. OFF	5,640
I-5 Mainline	73,185	I-5 Mainline	53,330
SR-500/39th ON	32,395	Victory/Denver ON	11,940
I-5 Mainline	105,580	I-5 Mainline	65,270
4th Plain OFF	11,420	Marine Dr. ON	17,930
I-5 Mainline	94,160	I-5 Mainline	83,200
4th Plain ON	6,180	Hayden Is. OFF	11,450
I-5 Mainline	100,340	I-5 Mainline	71,750
Mill Plain OFF	21,150	Hayden Is. ON	17,500
I-5 Mainline	79,190	I-5 Mainline at Interstate Bridge	89,250
Mill Plain ON	13,000		
I-5 Mainline	92,190		
SR 14 OFF	21,425	SR 14 OFF	17,120
I-5 Mainline	70,765	I-5 Mainline	72,130
SR 14 ON	18,485	City Center OFF	4,880
I-5 Mainline at Interstate Bridge	89,250	I-5 Mainline	67,250
SR14 ON	20,910		
I-5 Mainline	88,160		
Jantzen Beach OFF	10,595	Mill Plain/4th Pl OFF	18,480
I-5 Mainline	78,655	I-5 Mainline	69,680
Jantzen Beach ON	12,870	Mill Plain ON	20,480
I-5 Mainline	91,525	I-5 Mainline	90,160
Marine Drive OFF	17,800	4th Plain ON	12,850
I-5 Mainline	73,725	I-5 Mainline	103,010
Marine Drive ON	4,785	SR-500/39th OFF	33,485
I-5 Mainline	78,510	I-5 Mainline	69,525
Interstate Ave. OFF	9,870	SR-500/39th ON	8,310
I-5 Mainline	68,640	I-5 Mainline	77,835
Victory Blvd. ON	1,805	Main St. OFF	10,760
I-5 Mainline	70,445	I-5 Mainline	67,075
Columbia Blvd. ON	7,640	Main St. ON	4,935
I-5 Mainline South of Columbia Blvd. ON	78,085	I-5 Mainline North of Main St. ON	72,010

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APPENDIX H

Environmental Documentation

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS No:
2010/03196

January 19, 2011

John McAvoy, P.E.
Major Project Manager
Federal Highway Administration
Washington Division
Suite 501, Evergreen Plaza
711 South Capitol Way
Olympia, Washington 98501

R.F. Krochalis
Regional Administrator
Federal Transit Administration
915 Second Avenue, Suite 3142
Seattle, Washington 98174

Re: Endangered Species Act Section 7 Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations for the Columbia River Crossing (Federal #: HPP S001(250), Lower Columbia–Clatskanie Rivers (4th field HUC 17080003), Lower Columbia River (4th field HUC 17080006), and Lower Willamette River (4th field HUC 17090012), Oregon and Washington

Dear Messrs. Krochalis and McAvoy:

The enclosed document contains a biological Opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act (ESA) on the effects of the Federal Highway Administration (FHWA) and the Federal Transit Authority (FTA) partially funding the proposed Columbia River Crossing (CRC). The proposed CRC includes the replacement of the Interstate 5 freeway bridges across the lower Columbia River between Portland, Oregon and Vancouver, Washington. As co-leads, funding to design and engineer this project originates from the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), under sections 1101, 1701, 1702, and 5309 (23 U.S.C.) (New Starts Program).

In this Opinion, NMFS concluded that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) spring/summer run Chinook salmon, SR fall-run Chinook salmon, Columbia River (CR) chum salmon (*O. keta*), LCR coho salmon (*O. kisutch*), SR sockeye salmon (*O. nerka*), LCR steelhead (*O. mykiss*), UWR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, Snake River Basin (SRB) steelhead, southern green sturgeon (*Acipenser medirostris*), eulachon (*Thaleichthys pacificus*), or eastern Steller sea lion (*Eumetopias jubatus*), or result in the destruction or adverse modification of critical habitats designated for any of the above listed species, except LCR coho salmon, for which critical habitat is not proposed or designated, eulachon, for which critical habitat is proposed but not yet designated, and eastern Steller sea lion, which does not have critical habitat designated in the action area.

In addition, NMFS concurred with the FHWA and FTA's determination that the proposed action is not likely to adversely affect the southern resident killer whale (*Orcinus orca*). The southern resident killer whale does not have critical habitat designated in the action area.

As required by section 7 of the ESA, NMFS is providing an incidental take statement with the Opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the FHWA and FTA must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species considered in this Opinion, except for eastern Steller sea lion.

The NMFS did not include take of eastern Steller sea lions in this exemption because the FHWA and FTA are not authorized to take sea lions under section 101(a)(5) of the Marine Mammal Protection Act. If the FHWA and FTA obtain that authorization, they may request an amendment that will add eastern Steller sea lions to this exemption.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. These conservation recommendations are a subset of the ESA take statement's terms and conditions. Section 305(b)(4)(B) of the MSA requires Federal Agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the FHWA and FTA must explain why the recommendations will not be followed, including the justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

If you have questions regarding this consultation, please contact Devin Simmons, Fishery Biologist in the Willamette Basin Habitat Branch of the Oregon State Habitat Office, at 503.231.2313.

Sincerely,

for Michael Tehan

William W. Stelle, Jr.
Regional Administrator

cc: Jim Brick, ODFW
Frannie Brindle, ODOT
Jaimee Davis, USACE
Anne Friesz, WDFW
Alex Liverman, DEQ
Steve Morrow, CRC
Kathy Roberts, USFWS
Terry Swanson, WDOE
Yvonne Valette, USEPA

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APPENDIX I

Specialty Design Reports
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APPENDIX I-1

Bridge Scour Elevation
(Not included in this submittal)

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APPENDIX J

UIC Registration Forms
(Not included with this submittal)

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APPENDIX K

Supplements and Revisions
(Not included with this submittal)

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APPENDIX L

Miscellaneous Documents

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APPENDIX L-1

Groundwater Elevations

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APPENDIX L-2

Operation and Maintenance Standards

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    - Outside the Department of Human Services approved 2-year time of travel for a public water supply well, or
    - Demonstrate that the water wells are protected from pollutants entrained in stormwater discharged into the underground injection systems within these setback areas.
- Comply with DEQ requirements for vertical separation between the bottom of a UIC and the seasonal high groundwater level. The basic requirements are:
    - Underground injection systems that are more than 5 feet deep shall have a minimum vertical separation distance of 10 feet between the bottom of the underground injection system and the seasonal high water table.
    - Underground injection systems less than or equal to 5 feet deep shall have a minimum separation distance of 5 feet between the bottom of the injection system and the seasonal high water.

14.10.15 Operation and Maintenance

The proper operation, performance, structural integrity, and aesthetics of a stormwater treatment facility are dependent on routine inspection and adequate maintenance. Inspection schedule and maintenance guidelines for each facility are summarized in an Operation and Maintenance Manual prepared to assist personnel who maintain the facility.

General requirements include:

- **Discuss proposed stormwater treatment facilities with the responsible Maintenance District before selection and design. Maintenance input can help in selecting and developing BMPs that are maintainable.**
- All stormwater treatment facilities require an Operation and Maintenance Manual. Prepare an operation and maintenance manual as outlined in **Chapter 4**.
- Distribute all prepared manuals to the appropriate district maintenance office and Geo-Environmental's Senior Hydraulics Engineer. An inventory of prepared manuals can be viewed at the following website:

  Operation & Maintenance Manuals Website

- All facilities need to be assigned a drainage facility identification number (see 14.10.17 below). Guidance on obtaining a drainage facility identification number is outlined in **Chapter 17**.
- All stormwater treatment facility structures should be accessible by foot and necessary equipment (e.g., vactor truck or mowers) for inspection and maintenance. Access road

design criteria for pretreatment and primary treatment facilities are discussed in Appendices A, B, C, and D.

- Implement with Maintenance District concurreance: Manhole lids located in non-traffic areas outside or beyond the clear zone such as grassed areas or behind guardrail must be set 1 foot above finish ground so that manhole location is visible for locating and for maintenance. Lid elevations must match proposed finish grade in traffic areas.

14.10.16 Field Marking

Field markers are used to locate and identify ODOT stormwater facilities or alert maintenance crews of the location of a stormwater facility's maintenance area. There are three stormwater markers recommended for identifying, locating, or alerting. Two of these markers are used for marking above ground facilities and there is one marker applicable to underground stormwater facilities. ODOT's field marking process is outlined in **Chapter 17**.

14.10.17 Drainage Facility Identification Number

A drainage facility identification number (DFI) is a unique identifier assigned to each stormwater treatment and storage facility. It is used to associate or link the stormwater facility to an Operation and Maintenance Manual. The number is assigned by contacting the Geo-Environmental Section's Senior Hydraulics Engineer to obtain a unique "DFI". The Geo-Environmental Section will maintain a database of assigned Drainage Facility IDs. Guidance on obtaining a drainage facility identification number is outlined in **Chapter 17**.

Table 1: General Maintenance			
Maintenance Component	**Defect or Problem**	**Condition When Maintenance is Needed**	**Recommended Maintenance to Correct Problem**
Annual Visual Inspection and Maintenance	Routine inspection	**Facilities should be inspected annually prior to fall rains**. If appropriate, also inspect the facility after the first significant rain event following dry spell (e.g. the first 24-hour rainfall greater then 0.5 inches after summer)	Identify existing and potential operational problems. Repair damaged components that are critical to the operation of the feature (e.g. flow control valves, liners, underdrains, and pipes) as soon as practical. Schedule routine maintenance such as mowing, sump cleanout, lube moving parts, repairs, etc. If the facility is problematic, schedule additional inspections or maintenance. Repair or replace facility field markers according to Technical Bulletin GE10-01(B). A marked facility has an O&M Plan.
	Maintenance of ancillary structures, if present Examples include • Flow splitter manhole • Diversion manhole • Catch basin • Shut-off valve assembly • Pretreatment or primary treatment manhole • Large detention pipe • Vault • Outfall	Damage or problems are observed or anticipated during the annual inspection.	Grease moving parts to ensure proper operation. Remove sediment from sumps, vaults, catch basins, and structures to prevent the release of oil or sediment. Annual cleaning is recommended. The use of a Vactor® truck is allowed unless prohibited in the facility's O&M manual Repair or replace damaged orifice assembly/riser pipe. Restore to design standards. Be aware of possible confined space requirements. Repair or replace damaged gates, locks, chains, etc that are used to secure valves and access points to prevent vandalism
General	Temporary erosion control hampers maintenance	Erosion control remains from project construction (contractor did not remove)	Contact contractor to complete work OR remove temporary erosion control that is not specified in the O&M Plan.

Table 1: General Maintenance

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Spilled material has entered the pond or structures	Oil, fuel, or other pollutants are evident following a spill event or accident.	Utilize valves or other features, if present, to contain the spilled material. Remove and properly manage spilled material and contaminated soil. Contact Region HazMat or spill response company for spill cleanup assistance where appropriate. Contact a Region Hydraulic Engineer for technical assistance with pond restoration, if necessary.
	Litter (trash and debris)	Trash poses a hazard, inhibits function, or is aesthetically unacceptable (e.g. evidence of dumping).	Remove problematic trash and debris as soon as practical. There should be no evidence of dumping. Remove non-problematic trash in accordance with District litter practices.
	Insects	Insects interfere with maintenance activities.	Implement vector control in accordance with County Health and District practices.
	Vegetation growth (mowing and brushing)	Vegetation growth restricts access, limits sight distance, obstructs water flow, or interferes with maintenance activity.	Mow access, berms, bottom, and side-slopes of the facility as noted in the District Integrated Vegetation Management (IVM) Plan. Remove vegetation in or around grates that obstruct (or could obstruct) flow. Avoid mowing or removing vegetation that does not need to be controlled. Avoid removing vegetation too low to the ground. NOTE: Removing vegetation too near to the ground may result in scalping of the soil, unwanted damaged to vegetation, or growth of unwanted plant species. Heavy equipment is allowed within aboveground water quality and detention facilities unless access restrictions are listed in the O&M Manual.

Table 1: General Maintenance			
Maintenance Component	**Defect or Problem**	**Condition When Maintenance is Needed**	**Recommended Maintenance to Correct Problem**
	Noxious weed growth	Control of noxious weeds is required by law or prescribed in the District IVM Plan	Remove noxious weeds in accordance with the District IVM Plan. Follow Environmental Protection Agency (EPA) label and ODOT policies on herbicide usage.
General	Hazard trees	Trees are found to be weakened, unsound, undermined, leaning, or exposed and may fall across the highway	Remove hazard trees as soon as practical. Where appropriate, consult an ODOT Forester for help identifying or removing hazard trees.
	Tree growth	Tree growth restricts access, obstructs function, jeopardizes infrastructure, or interferes with maintenance actions.	Prune or remove as needed to maintain access, function, and tree health. Manage potentially problematic woody material before the trees reach 6 inches diameter at breast height (DBH). Consult an ODOT Forester for the removal or management of trees greater than 6 inches DBH. Obtain permits where appropriate. Refer to the District IVM Plan for the management of smaller trees. Avoid removing trees that will not interfere with the operation or maintenance of the facility.

Table 2: Maintenance of Stormwater Ponds

Stormwater ponds should retain water and slowly release by either infiltration or outflow.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Follow applicable Guidance from Table 1 AND applicable guidance from this table.		
	Vegetation growth in **dry ponds** (mowing and brushing)	Vegetation growth restricts access, limits sight distance, obstructs water flow, or interferes with maintenance activity. Collected water should drain.	Dry ponds need vegetation on the bottom and sides. Vegetation management typically occurs around and within the facility. Mow access, berms, bottom, and side-slopes as noted in the District Integrated Vegetation Management (IVM) Plan. (typically annually) Heavy equipment is allowed on dry pond bottoms unless access restrictions are listed in the O&M Manual.
	Vegetation growth in **wet ponds** (mowing and brushing) NOTE: Wet ponds are not typical.	Vegetation growth restricts access, limits sight distance, obstructs water flow, or interferes with maintenance activity. Water may be stored year-round without draining.	Wet ponds need vegetation on the bottom and sides. Vegetation management typically occurs around the facility. Mow access and berms as noted in the District Integrated Vegetation Management (IVM) Plan. Ponds bottoms are intended to capture and store water. Vegetation removal from pond bottoms is infrequent.
	Sediment accumulation in pre-treatment features (e.g. forebays, basins, or fully exposed impermeable liners) NOTE: Exposed liners are not typical.	Sediment affects flow. Sediment jeopardizes infrastructure.	Remove sediment from ponds and pipe ends as needed to ensure adequate drainage into treatment pond (grassy or wet pond). Use methods that minimize disturbance to surrounding vegetation. Heavy equipment is allowed on dry pond bottoms unless access restrictions are listed in the O&M Manual. Sediment may contain oil and other pollutants, especially in areas with high ADT. Refer to the ODOT Maintenance Environmental Management System (EMS) Manual for the disposal of contaminated sediment. Note: Pollutant concentrations may increase if sediment is not routinely removed.

Table 2: Maintenance of Stormwater Ponds

Stormwater ponds should retain water and slowly release by either infiltration or outflow.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
Storage areas	Sediment accumulation along bottom of grassy ponds	Sediment inhibits the flow of water through the grass (>12 inches deep). Sediment inhibits grass growth.	Where practical use a Vactor® truck to remove sediment from grassy areas. When Vactoring® is not practical, follow ditch cleaning practices. Restore slope and geometry to design standards, if necessary. Reseed grass cover where needed. Stormwater should infiltrate or flow toward outlet once inflow has ceased. Refer to the general section of this table for side-slope mowing and other routine maintenance actions.
	Sediment accumulation in wet ponds or channels. NOTE: Currently there is limited use of wet ponds to treat stormwater.	Capacity has noticeably decreased (examples below) • low and medium flows go through the bypass, • the ordinary high water level has increased, • flooding occurs when the outflows are not blocked, • pond bottom is level with outlets.	Remove sediment build-up from pipe ends as needed to ensure flow. Use methods that minimize disturbance to surrounding vegetation. Remove sediment to restore designed shape and depth. In high ADT areas, pond dredging may be required every 5 to 10 years to restore the capacity. Cease sediment removal when riprap or liner is encountered. Reseed if necessary to control erosion.
	Erosion	Side slopes show evidence of erosion greater than 4 inches deep and the potential for continued erosion is evident.	Promptly address erosion that causes immediate problems (e.g. damage to highway or highway structure) Schedule non-urgent repairs with routine work. Stabilize slope using appropriate erosion control and repair methods. Repair the cause of the erosion where possible. If necessary, contact the ODOT Erosion Control Coordinator to evaluate the condition.

Table 2: Maintenance of Stormwater Ponds

Stormwater ponds should retain water and slowly release by either infiltration or outflow.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
Storage areas	Beaver dams	Dam inhibits function or jeopardizes the infrastructure.	Dispose of dam debris offsite or outside of the riparian area. Coordinate the removal or relocation of beaver with Oregon Department of Fish and Wildlife (ODFW). Consider installing deterrents where appropriate.
	Flooding	Water is flowing over or is approaching the top of the pond	Check storm drain pipes and structures for blockage. Ensure valves are open. Remove obstructions to restore flow. Evaluate and remove excessive sediment from pond storage areas. Contact the Region Hydraulic Engineer to evaluate the source of flooding or provide design modifications.
Treatment Components	Poor vegetation coverage	Vegetation (grass) is sparse or eroded patches occur in more than 10 percent of pond bottom.	Repair and reseed as appropriate to restore coverage. Install erosion control measures as needed. Trim overhanging limbs and remove brushy vegetation that limit grass growth (provide too much shade).
	Missing or eroded amended soil mix	Bare soil is observed over 10 percent of the amended area.	Identify and resolve erosion problem Add amended soil. Contact a Region Hydraulics Engineer for required material specifications.
	Amended soil mix along pond bottom is clogged	Standing water is observed for seven (7) consecutive days or longer from May through October.	Remove and replace amended soil mix. Contact a Region Hydraulics Engineer for required material specifications. Replace or repair damaged underlying drainage geotextile, impermeable liner, drain piping, and granular drain backfill material when applicable.
	Granular drain backfill material for underdrain pipe plugged	Amended soil mix has been replaced and standing water is still observed for seven (7) consecutive days or longer from May through October.	Remove and replace granular drain backfill material. Contact a Region Hydraulics Engineer for required material specifications. Install new drainage geotextile over new granular drain backfill material. Replace amended soil mix.

Table 2: Maintenance of Stormwater Ponds Stormwater ponds should retain water and slowly release by either infiltration or outflow.			
Maintenance Component	**Defect or Problem**	**Condition When Maintenance is Needed**	**Recommended Maintenance to Correct Problem**
Treatment Components	Impermeable liner damage NOTE: Liners (if installed) are typically below the grass surface and may not be visible.	Liner is damaged (e.g. during sediment removal or by motoring public). Liner is damaged when condition allows potential contamination to be released to the subsurface.	Repair or replace the liner with similar material. In many cases, rigid plastic liners may be repaired by welding a similar material over the damaged portion or using a non-toxic, waterproof epoxy. If necessary, contact a Region Hydraulics Engineer for technical assistance regarding permanent repair.
Berms and Dikes	Settlement	Any part of the berm has settled 4 inches or lower. Note: Settlement may indicate potential problems with the facility.	Repair berm to design height with similar materials. Contact a Region Hydraulics and Geotechnical Engineer as needed to evaluate the source of the settlement and determine repair options.
	Flow-through	Water is flowing through the pond berm.	Correct cause of flow through (e.g. eliminate burrowing rodents) Install erosion control measures where appropriate. Repair berm with similar materials. If necessary, contact a Region Geotechnical Engineer to evaluate the condition.
	Sloughing	Ongoing erosion is observed with potential for erosion to continue.	Where possible correct the cause of the erosion. Install or replace energy dissipaters where appropriate. Install erosion control measures where appropriate Repair berm with similar materials. If necessary, contact the ODOT Erosion Control Coordinator to evaluate the condition.

Table 2: Maintenance of Stormwater Ponds Stormwater ponds should retain water and slowly release by either infiltration or outflow.			
Maintenance Component	**Defect or Problem**	**Condition When Maintenance is Needed**	**Recommended Maintenance to Correct Problem**
Structures and piping Includes • flow splitters • vaults • inlets • bypasses • valves • catch basins • gates	Damaged or missing components	Flow control assembly is not working properly (e.g. loose, bent, unattached, etc.).	Repair or replace valves, gates, orifices and pipes as necessary with similar components. Divert flows when needed.
	Obstruction or blockage	Water does not flow in, through, or out of the structure or piping.	If valves are part of the flow control assembly, verify the valves are open. Refer to the O&M for the location of control valves. Remove obstructions to restore flow (e.g. remove trash, debris, sediment, or vegetation as necessary). Jet rodders may be used to clean piping unless specifically prohibited in the O&M plan.
Outfalls	Insufficient rock armoring at outlets • along channel side slopes and bottom • pipe outlet • along the length of spillway	Minimal layer of rock exists Rock missing along armored area Flow channelization or high flows exposed native soil around the rock armored area	Install erosion control measures Repair or replace rock armoring to original design standard Repair, re-grade, and reseed eroded areas adjacent to rock armoring. Contact a Region Hydraulics Engineer for technical assistance if rock armoring problems continue or a highway structure is at risk

Table 3: Maintenance of Water Quality or Biofiltration Swales Swales should provide even sheet flow that moves water from the inlet to the outlet.			
Maintenance Component	**Defect or Problem**	**Condition When Maintenance is Needed**	**Recommended Maintenance to Correct Problem**
General	Follow applicable Guidance from Table 1 AND applicable guidance from this table.		
	Vegetation growth (mowing and brushing)	Vegetation growth restricts access, limits sight distance, obstructs water flow, or interferes with maintenance activity. **Swales should be mowed annually.**	Mow access, berms, swale, and side-slopes as noted in the District Integrated Vegetation Management (IVM) Plan. The use of heavy equipment is allowed unless access restrictions are listed in the O&M Manual.
Swale Components	Sediment accumulation in pre-treatment areas or ancillary structures (e.g. manholes)	Sediment affects flow. Sediment jeopardizes infrastructure.	Remove sediment that prevents adequate drainage into swale. Use methods that minimize disturbance to surrounding vegetation. The use of heavy equipment is allowed unless access restrictions are listed in the O&M Manual. Sediment may contain oil and other pollutants, especially in areas with high ADT. Refer to the ODOT Maintenance Environmental Management System (EMS) Manual for the disposal of contaminated sediment. Note: Pollutant concentrations may increase if sediment is not routinely removed.
	Sediment accumulation along swale bottom	Sediment inhibits the flow of water through the grass (e.g. water is ponding or cutting a channel).	Remove sediment from grassy areas. The use of a Vactor® truck is allowed unless access restrictions are listed in the O&M Manual. Restore slope and geometry to design standards, if necessary. Reseed grass cover where needed. Stormwater should infiltrate or flow toward outlet once inflow has ceased.

Table 3: Maintenance of Water Quality or Biofiltration Swales

Swales should provide even sheet flow that moves water from the inlet to the outlet.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
Swale Components	Erosion	Side slopes show evidence of erosion greater than 2 inches deep and the potential for continued erosion is evident.	Promptly address erosion that causes immediate problems (e.g. damage to highway or highway structure) Schedule non-urgent repairs with routine work. Stabilize slope using appropriate erosion control and repair methods. Repair the cause of the erosion where possible. If necessary, contact the ODOT Erosion Control Coordinator to evaluate the condition.
	Poor vegetation coverage	Vegetation (grass) is sparse or eroded patches occur in more than 10 percent of swale. NOTE: A single incident (e.g. vehicle accident) typically effects less than 10 percent of the area and is unlikely to trigger a repair.	Repair and reseed as appropriate to restore coverage. Install erosion control measures as needed. Trim overhanging limbs and remove brushy vegetation that limit grass growth (provide too much shade).
	Missing or eroded amended soil mix	Bare soil is observed over 10 percent of the amended area.	Identify and resolve erosion problem Add amended soil. Contact a Region Hydraulics Engineer for required material specifications.
	Amended soil mix along swale bottom is clogged	Standing water is observed for seven (7) consecutive days or longer from May through October.	Remove and replace amended soil mix. Contact a Region Hydraulics Engineer for required material specifications. Replace or repair damaged underlying drainage geotextile, impermeable liner, drain piping, and granular drain backfill material when applicable.
	Granular drain backfill material for underdrain pipe plugged	Amended soil mix has been replaced and standing water is still observed for seven (7) consecutive days or longer from May through October.	Remove and replace granular drain backfill material. Contact a Region Hydraulics Engineer for required material specifications. Install new drainage geotextile over new granular drain backfill material. Replace amended soil mix.

Table 3: Maintenance of Water Quality or Biofiltration Swales

Swales should provide even sheet flow that moves water from the inlet to the outlet.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
Swale Components	Impermeable liner damage NOTE: Liners may not be visible. If present, liners are typically below the grass surface along the bottom of the swale Fabric wrapped around underdrains is not a liner.	Liner is damaged (e.g. during sediment removal or by motoring public). Liner is damaged when condition allows potential contamination to be released to the subsurface.	Repair or replace the liner with similar material. Replace top soil and grass as appropriate. Features with liners, typically have maintenance option limitations; check the O&M Manual. If necessary, contact a Region Hydraulics Engineer for technical assistance.
	Obstruction or blockage of pipes	Water does not flow in, through, or out of the swale.	Remove obstructions to restore flow (e.g. remove trash, debris, sediment, or vegetation as necessary). Jet rodders may be used to clean piping unless specifically prohibited in the O&M plan.
	Flow spreader is uneven or clogged	Water does not flow evenly across the structure	Clean sump or forebay as needed to maintain capacity. Clean or repair spreader as needed to provide a uniform flow and prevent erosion. Level portions of the flow spreader that have settled.

Table 4: Filter Strips

Filter strips should provide even sheet flow that moves water from edge of pavement toward a downslope conveyance.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Follow applicable Guidance from Table 1 AND applicable guidance from this table.		
	Vegetation growth (mowing and brushing)	Vegetation growth restricts access, limits sight distance, obstructs water flow, or interferes with maintenance activity. **Filter strips should be mowed annually.**	Mow as noted in the District Integrated Vegetation Management (IVM) Plan. The use of heavy equipment is allowed unless access restrictions are listed in the O&M Manual.
Filter Strip Components	Sediment accumulation	Sediment inhibits the flow of water through the grass (e.g. water is ponding or cutting a channel).	Remove sediment from grassy areas. The use of a Vactor® truck is allowed unless access restrictions are listed in the O&M Manual. Restore slope and geometry to design standards, if necessary. Reseed grass cover where needed.
	Missing or eroded amended soil mix	Bare soil is observed over 10 percent of the amended area.	Identify and resolve erosion problem Add amended soil. Contact a Region Hydraulics Engineer for required material specifications.
	Amended soil mix is clogged	Standing water is observed for seven (7) consecutive days or longer from May through October.	Remove and replace amended soil mix. Contact a Region Hydraulics Engineer for required material specifications. Replace or repair damaged underlying drainage geotextile, impermeable liner, drain piping, and granular drain backfill material when applicable.
	Flow spreader is uneven or clogged	Water does not flow evenly across the structure	Clean or repair spreader as needed to provide a uniform flow and prevent erosion. Level portions of the flow spreader that have settled.
	Erosion or rutting	Areas have eroded or channelized due to high flows or vehicular damage	Repair, regrade, and reseed (as needed) to restore uniform flow across grass.
	Poor vegetation coverage	Vegetation (grass) is sparse or eroded patches occur in more than 10% of the strip. NOTE: A single incident is unlikely to trigger a repair.	Repair and reseed as appropriate to restore coverage. Install erosion control measures as needed.

Table 5: Bioslopes

Bioslopes should provide even sheet flow that moves water from edge of pavement.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Follow applicable Guidance from Table 1 AND applicable guidance from this table.		
	Vegetation growth (mowing and brushing)	Vegetation growth restricts access, limits sight distance, obstructs water flow, or interferes with maintenance activity. **Slopes should be mowed annually.**	Mow as noted in the District Integrated Vegetation Management (IVM) Plan. The use of heavy equipment is allowed unless access restrictions are listed in the O&M Manual.
Bioslope Components	Sediment accumulation	Sediment inhibits the flow of water to the bioslope (e.g. water is ponding or cutting a channel).	Remove sediment from grassy areas. The use of a Vactor® truck is allowed unless access restrictions are listed in the O&M Manual. Restore slope and geometry to design standards, if necessary. Reseed grass cover where needed.
	Ecology mix is clogged	Standing water is observed for seven (7) consecutive days or longer from May through October.	Remove and replace ecology mix. Contact a Region Hydraulics Engineer for required material specifications. Replace or repair damaged underlying drainage geotextile, impermeable liner, drain piping, and granular drain backfill material when applicable.
	Granular drain backfill material for underdrain pipe plugged	Ecology mix has been replaced and standing water is still observed for seven (7) consecutive days or longer from May through October.	Remove and replace granular drain backfill material. Contact a Region Hydraulics Engineer for required material specifications. Install new drainage geotextile over new granular drain backfill material. Replace amended soil mix.
	Poor vegetation coverage	Vegetation (grass) is sparse or eroded patches occur in more than 10 percent of the strip	Repair and reseed as appropriate to restore coverage. Install erosion control measures as needed.

5-5 Operation and Maintenance

Inadequate maintenance is a common cause of failure for stormwater control facilities. All stormwater facilities require routine inspection and maintenance and thus must be designed so that these functions can be easily conducted.

5-5.1 Typical BMP Maintenance Standards

The facility-specific maintenance standards contained in this section (see Tables 5.5.1 through 5.5.13) are intended to be used for determining when maintenance actions are required for conditions identified through inspection. They are not intended to be measures of a facility's required condition at all times between inspections. In other words, exceeding these conditions at any time between inspections or maintenance does not automatically constitute a need for immediate maintenance. Based upon inspection observations, however, the inspection and maintenance schedules must be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

5-5.2 Natural and Landscaped Areas Designated as Stormwater Management Facilities

Maintenance of natural and landscaped areas designated as stormwater management facilities requires special attention. Generally, maintenance in these areas should be performed with light equipment. Heavy machinery and vehicles with large treads or tires can compact the ground surface, decreasing the effectiveness of the BMPs.

Table 5.5.1. Maintenance standards for detention ponds.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Accumulations exceed 5 cubic feet (about equal to the amount of trash needed to fill one standard-size garbage can) per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold, all trash and debris will be removed as part of the next scheduled maintenance.	Trash and debris are cleared from site.
	Poisonous vegetation and noxious weeds	Poisonous or nuisance vegetation may constitute a hazard to maintenance personnel or the public. Noxious weeds as defined by state or local regulations are evident. (Apply requirements of adopted integrated pest management [IPM] policies for the use of herbicides).	No danger is posed by poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department.) Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies is required.
	Contaminants and pollution	Oil, gasoline, contaminants, or other pollutants are evident. (Coordinate removal/cleanup with local water quality response agency.)	No contaminants or pollutants are present.
	Rodent holes	For facilities acting as a dam or berm: rodent holes are evident or there is evidence of water piping through dam or berm via rodent holes.	Rodents are destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies.)
	Insects	Insects such as wasps and hornets interfere with maintenance activities.	Insects are destroyed or removed from site. Insecticides are applied in compliance with adopted IPM policies.
	Tree growth and hazard trees	Tree growth does not allow maintenance access or interferes with maintenance activity (slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. Dead, diseased, or dying trees are observed. (Use a certified arborist to determine health of tree or removal requirements.)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (such as alders for firewood). Hazard trees are removed.
Side slopes of pond	Erosion	Eroded damage is over 2 inches deep and cause of damage is still present, or there is potential for continued erosion. Erosion is observed on a compacted berm embankment.	Slopes are stabilized using appropriate erosion control measures (such as rock reinforcement, planting of grass, and compaction). If erosion is occurring on compacted berms, a licensed civil engineer should be consulted to resolve source of erosion.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage area	Sediment	Accumulated sediment exceeds 10% of the designed pond depth, unless otherwise specified, or affects inletting or outletting condition of the facility.	Sediment is cleaned out to designed pond shape and depth. Pond is reseeded if necessary to control erosion.
	Liner (if applicable)	Liner is visible and has more than three ¼-inch holes in it.	Liner is repaired or replaced. Liner is fully covered.
Pond berms (dikes)	Settlements	Any part of berm has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Water flow is discernible through pond berm. Ongoing erosion is observed, with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping is eliminated. Erosion potential is resolved.
Emergency overflow/ spillway and berms over 4 feet high	Tree growth	Tree growth on emergency spillways reduces spillway conveyance capacity and may cause erosion elsewhere on the pond perimeter due to uncontrolled overtopping. Tree growth on berms over 4 feet high may lead to piping through the berm, which could lead to failure of the berm and related erosion or flood damage.	Trees should be removed. If root system is small (base less than 4 inches), the root system may be left in place; otherwise, the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Water flow is discernible through pond berm. Ongoing erosion is observed, with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping is eliminated. Erosion potential is resolved.
Emergency overflow/ spillway	Spillway lining insufficient	Only one layer of rock exists above native soil in area 5 square feet or larger, or native soil is exposed at the top of outflow path of spillway. (Riprap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.

Table 5.5.2. Maintenance standards for bioinfiltration ponds/infiltration trenches/basins.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
	Poisonous/noxious vegetation	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
	Contaminants and pollution	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
	Rodent holes	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
Storage area	Sediment	Water ponds in infiltration pond after rainfall ceases and appropriate time has been allowed for infiltration. (A percolation test pit or test of facility indicates facility is working at only 90% of its designed capabilities. If 2 inches or more of sediment present, remove sediment).	Sediment is removed or facility is cleaned so that infiltration system works according to design.
Rock filters	Sediment and debris	By visual inspection, little or no water flows through filter during heavy rainstorms.	Gravel in rock filter is replaced.
Side slopes of pond	Erosion	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
Emergency overflow/spillway and berms over 4 feet high	Tree growth	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
	Piping	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
Emergency overflow/spillway	Rock missing	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
	Erosion	See Table 5.5.13 (wet ponds).	See Table 5.5.13 (wet ponds).
Presettling ponds and vaults	Facility or sump filled with sediment or debris	Sediment/debris exceeds 6 inches or designed sediment trap depth.	Sediment is removed.

Table 5.5.3. Maintenance standards for closed treatment systems (tanks/vaults).

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage area	Plugged air vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents are open and functioning.
	Debris and sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for ½ length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank requires cleaning when sediment reaches depth of 7 inches for more than ½ the length of the tank.)	All sediment and debris are removed from storage area.
	Joints between tank/pipe section	Openings or voids allow material to be transported into facility. (Will require engineering analysis to determine structural stability.)	All joints between tank/pipe sections are sealed.
	Tank/pipe bent out of shape	Any part of tank/pipe is bent out of shape for more than 10% of its design shape. (Review required by engineer to determine structural stability.)	Tank/pipe is repaired or replaced to design specifications.
	Vault structure: includes cracks in walls or bottom, damage to frame or top slab	Cracks are wider than ½ inch and there is evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault is replaced or repaired to design specifications and is structurally sound.
		Cracks are wider than ½ inch at the joint of any inlet/outlet pipe, or there is evidence of soil particles entering the vault through the walls.	No cracks are more than ¼-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover not in place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than ½ inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. *Intent: To prevent cover from sealing off access to maintenance.*	Cover can be removed and reinstalled by one maintenance person.
	Ladder unsafe	Ladder is unsafe due to missing rungs, misalignment, insecure attachment to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch basins	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).

Table 5.5.4. Maintenance standards for control structure/flow restrictor.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris (includes sediment)	Accumulation exceeds 25% of sump depth or is within 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris are removed.
	Structural damage	Structure is not securely attached to manhole wall.	Structure is securely attached to wall and outlet pipe.
		Structure is not in upright position; allow up to 10% from plumb.	Structure is in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are watertight; structure is repaired or replaced and works as designed.
		Holes other than designed holes are observed in the structure.	Structure has no holes other than designed holes.
Cleanout gate	Damaged or missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice plate	Damaged or missing	Control device is not working properly due to missing, out-of-place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Trash, debris, sediment, or vegetation blocks the plate.	Plate is free of all obstructions and works as designed.
Overflow pipe	Obstructions	Trash or debris blocks (or has the potential to block) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See Table 5.5.3 (closed treatment systems).	See Table 5.5.3 (closed treatment systems).	See Table 5.5.3 (closed treatment systems).
Catch basin	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).	See Table 5.5.5 (catch basins).

Table 5.5.5. Maintenance standards for catch basins.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Trash or debris is immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris is immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case is clearance less than 6 inches from the debris surface to the invert of the lowest pipe.	No trash or debris is in the catch basin.
		Trash or debris in any inlet or outlet pipe blocks more than ⅓ of its height.	Inlet and outlet pipes are free of trash or debris.
		Dead animals or vegetation could generate odors that might cause complaints or dangerous gases (such as methane).	No vegetation or dead animals are present within the catch basin.
	Sediment	Sediment (in the basin) exceeds 60% of the sump depth as measured from the bottom of the basin to invert of the lowest pipe into or out of the basin, but in no case is clearance less than 6 inches from the sediment surface to the invert of the lowest pipe.	No sediment is in the catch basin.
	Structure damage to frame and/or top slab	Top slab has holes larger than 2 square inches or cracks wider than ¼ inch. *Intent: To make sure no material is running into basin.*	Top slab is free of holes and cracks.
		Frame is not sitting flush on top slab (separation of more than ¾ inch of the frame from the top slab). Frame is not securely attached.	Frame is sitting flush on the riser rings or top slab and is firmly attached.
	Fractures or cracks in basin walls/bottom	Maintenance person judges that structure is unsound.	Basin is replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe, or there is evidence that soil particles have entered catch basin through cracks.	Pipe is regrouted and secure at the basin wall.
	Settlement/ misalignment	Failure of basin has created a safety, function, or design problem.	Basin is replaced or repaired to design standards.
	Vegetation	Vegetation is growing across and blocking more than 10% of the basin opening.	No vegetation blocks the opening to the basin.
		Vegetation growing in inlet/outlet pipe joints is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth is present.
	Contamination and pollution	Oil, gasoline, contaminants, or other pollutants are evident. (Coordinate removal/cleanup with local water quality response agency.)	No pollution is present.
Catch basin cover	Cover not in place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than ½ inch of thread.	Mechanism opens with proper tools.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Catch basin cover (continued)	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. *Intent: To prevent cover from sealing off access to maintenance.*	Cover can be removed by one maintenance person.
Ladder	Ladder unsafe	Ladder is unsafe due to missing rungs, insecure attachment to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance staff safe access.
Metal grates (if applicable)	Grate opening unsafe	Grate opening is wider than ⅞ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris block more than 20% of grate surface inletting capacity.	Grate is free of trash and debris.
	Damaged or missing	Grate is missing or components of the grate are broken.	Grate is in place and meets design standards.

Table 5.5.6. Maintenance standards for debris barriers (such as trash racks).

Maintenance Components	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and debris	Trash or debris plugs more than 20% of the openings in the barrier.	Barrier is cleared to design flow capacity.
Metal	Damaged/missing bars	Bars are bent out of shape more than 3 inches.	Bars are in place with no bends more than ¾ inch.
		Bars are missing or entire barrier is missing.	Bars are in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier is replaced or repaired to design standards.
	Inlet/outlet pipe	Debris barrier is missing or not attached to pipe.	Barrier is firmly attached to pipe.

Table 5.5.7. Maintenance standards for energy dissipaters.

Maintenance Components	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock pad	Missing or moved rock	Only one layer of rock exists above native soil in area 5 square feet or larger, or native soil is exposed.	Rock pad is replaced to design standards.
	Erosion	Soil erosion is evident in or adjacent to rock pad.	Rock pad is replaced to design standards.
Dispersion trench	Pipe plugged with sediment	Accumulated sediment exceeds 20% of the design depth.	Pipe is cleaned/flushed so that it matches design.
	Not discharging water properly	There is visual evidence of water discharging at concentrated points along trench—normal condition is a "sheet flow" of water along trench. *Intent: To prevent erosion damage.*	Trench is redesigned or rebuilt to standards.
	Perforations plugged	Over ½ of perforations in pipe are plugged with debris and sediment.	Perforated pipe is cleaned or replaced.
	Water flows out top of "distributor" catch basin	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm, or water is causing (or appears likely to cause) damage.	Facility is rebuilt or redesigned to standards.
	Receiving area over-saturated	Water in receiving area is causing (or has potential of causing) landslide problems.	There is no danger of landslides.
Internal:			
Manhole/chamber	Worn or damaged post, baffles, side of chamber	Structure dissipating flow deteriorates to ½ of original size or any concentrated worn spot exceeds 1 square foot, which would make structure unsound.	Structure is replaced to design standards.
	Other defects	See entire contents of Table 5.5.5 (catch basins).	See entire contents of Table 5.5.5 (catch basins).

Table 5.5.8. Maintenance standards for biofiltration swale.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing water	Water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages; improve grade from head to foot of swale; remove clogged check dams; add underdrains; or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant baseflow	Small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea gravel drain the length of the swale, or bypass the baseflow around the swale.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Replant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals; or reseed into loosened, fertile soil.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches. Mowing is not required for wet biofiltration swales. However, fall harvesting of very dense vegetation after plant die-back is recommended.
	Excessive shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/outlet	Inlet/outlet areas are clogged with sediment/debris.	Remove material so there is no clogging or blockage in the inlet and outlet area.
	Trash and debris	Trash and debris have accumulated in the swale.	Remove trash and debris from bioswale.
	Erosion/scouring	Swale bottom has eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large (generally greater than 12 inches wide), the swale should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Table 5.5.9. Maintenance standards for vegetated filter strip.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height between 3 and 4 inches.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Remove trash and debris from filter.
	Erosion/scouring	Areas have eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table 5.5.10. Maintenance standards for media filter drain.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean so that flows are spread evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Consult with roadside vegetation specialists to determine why grass growth is poor and correct the offending condition. Replant with plugs of grass from the upper slope or reseed into loosened, fertile soil or compost.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
	Media filter drain mix replacement	Water is seen on the surface of the media filter drain mix from storms that are less than a 6-month, 24-hour precipitation event. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the media filter drain mix contained within the media filter drain.
	Excessive shading	Grass growth is poor because sunlight does not reach embankment.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.

Table 5.5.11. Maintenance standards for permeable pavement.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation	Collection of sediment is too coarse to pass through pavement.	Remove sediment deposits with high-pressure vacuum sweeper.
	Accumulation of leaves, needles, and other foliage	Accumulation on top of pavement is observed.	Remove with a leaf blower or high-pressure vacuum sweeper.
	Trash and debris	Trash and debris have accumulated on the pavement.	Remove by hand or with a high-pressure vacuum sweeper.
	Oil accumulation	Oil collection is observed on top of pavement.	Immediately remove with a vacuum and follow up by a pressure wash or other appropriate rinse procedure.
Visual facility identification	Not aware of permeable pavement location	Facility markers are missing or not readable.	Replace facility identification where needed.
Annual minimum maintenance			Remove potential void-clogging debris with a biannual or annual high-pressure vacuum sweeping.

Table 5.5.12. Maintenance standards for dispersion areas (natural and engineered).

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment accumulation on dispersion area	Sediment depth exceeds 2 inches.	Remove sediment deposits while minimizing compaction of soils in dispersion area Relevel so slope is even and flows pass evenly over/through dispersion area. Handwork is recommended rather than use of heavy machinery.
	Vegetation	Vegetation is sparse or dying; significant areas are without ground cover.	Control nuisance vegetation. Add vegetation, preferably native ground cover, bushes, and trees (where consistent with safety standards) to bare areas or areas where the initial plantings have died.
	Trash and debris	Trash and debris have accumulated on the dispersion area.	Remove trash and debris from filter. Handwork is recommended rather than use of heavy machinery.
	Erosion/scouring	Eroded or scoured areas due to flow channelization, or high flows are observed.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel/compost mix (see Section 5-4.3.2 for the compost specifications). The grass will creep in over the rock mix in time. If bare areas are large (generally greater than 12 inches wide), the dispersion area should be reseeded. For smaller bare areas, overseed when bare spots are evident. Look for opportunities to locate flow spreaders, such as dispersion trenches and rock pads.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table 5.5.13. Maintenance standards for wet ponds.

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Water level	First cell is empty, doesn't hold water	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and debris	Accumulations exceed 1 cubic foot per 1000 square feet of pond area.	Remove trash and debris from pond.
	Inlet/outlet pipe	Inlet/outlet pipe is clogged with sediment or debris material.	Unclog and unblock inlet and outlet piping.
	Sediment accumulation in pond bottom	Sediment accumulations in pond bottom exceed the depth of sediment zone plus 6 inches, usually in the first cell.	Remove sediment from pond bottom.
	Oil sheen on water	Oil sheen is prevalent and visible.	Remove oil from water using oil-absorbent pads or Vactor truck. Locate and correct source of oil. If chronic low levels of oil persist, plant wetland species such as *Juncus effusus* (soft rush), which can uptake small concentrations of oil.
	Erosion	Pond side slopes or bottom show evidence of erosion or scouring in excess of 6 inches and the potential for continued erosion is evident.	Stabilize slopes using proper erosion control measures and repair methods.
	Settlement of pond dike/berm	Any part of the pond dike/berm has settled 4 inches or lower than the design elevation, or the inspector determines dike/berm is unsound.	Repair dike/berm to specifications.
	Internal berm	Berm dividing cells are not level.	Level berm surface so that water flows evenly over entire length of berm.
	Overflow/spillway	Rock is missing and soil exposed at top of spillway or outside slope.	Replace rocks to specifications.

APPENDIX L-3

Franchise and Permits Issued in DOT Right-of-Way

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Permits Issued by ODOT for I-5 Right-of-Way

Permit No.	Year Issued	Utility Type	Applicant	Comments
4734	1955	Communications	Pacific Telephone & Telegraph Company	MP 6.24 (prior Mile Post system). Telephone cable crossing.
6142	1962	Communications	Pacific Northwest Bell	MP 307.45. U/G telephone cable.
5225	1964	Communications	Pacific Northwest Bell	MP 6.63 - 6.77 (prior Mile Post system). Telephone cable. Modified later.
11761	1967	Water	Hayden Island, Inc.	MP 308.02. 6" steel. Not shown on City of Portland data - could be abandoned.
11973	1967	Electricity	Portland General Electric	MP 307.69. U/G 11 kV crossing. Amended in Salem Permit Office.
12240	1968	Sewer	Hayden Island, Inc	MP 6.28 (prior Mile Post system). 8" welded steel pipe.
12259	1971	Communications	Pacific Northwest Bell	Location on attached map is not clear: it is likely at intersection of Hayden Island Drive and Center Avenue.
13509	1970	Water	Hayden Island, Inc.	MP 7.69 (prior Mile Post system). 12" pipe. Replaced - see Permit #30861.
13681	1970	Electricity	Portland General Electric	MP 6.59 - 6.60 (prior Mile Post system). 17kV buried cable and switch/transformer house. Current configuration not as shown on the permit.
14228	1971	Gas	Northwest Natural Gas Company	MP 307.69 - 307.99. 2" and 4" pipe.
15306	1972	Water	City of Portland	MP 307.06. 24" casing for 16" steel main.
15572	1972	Water	City of Portland	MP 307.05. 16" DIP crossing.
16216	1973	Communications	City of Portland	MP 307.48 - 307.70. Fire alarm cable suspended under Oregon Slough Bridge. Not shown for security reasons.
17675	1976	Communications	Pacific Northwest Bell	MP 308.14 - 308.16. Concrete parking area.
18599	1977	Sewer	City of Portland	MP 306.64 - 306.83. 6" DIP forcemain.
19107	1977	Gas	Northwest Natural Gas Company	MP 308.15 - 308.17. 2" steel.
20738	1979	Communications	Pacific Northwest Bell	MP 368.25. U/G cable. Mile Post is incorrect.
25437	1985	Communications	Pacific Northwest Bell	MP 307.45. U/G telephone cable and cable suspended under North Portland Harbor Bridge deck.
27148	1987	Communications	Roger's Cable Systems	MP 307.47 - 307.70. U/G TV cable and suspended cable under North Portland Harbor Bridge deck.
30693	1990	Water	City of Portland	MP 307.33 - 307.51. 16" DIP.
30861	1990	Water	City of Portland	MP 308.06 - 308.16. 12" DIP.
2BM35007	1990	Gas	Northwest Natural Gas Company	MP 307.32 - 307.47. 8" steel line.
2BM35178	1992	Sewer	City of Portland	MP 307.70. 10" PVC forcemain crossing.
2BM35338	1993	Communications	Red Lion Inn	MP 308.00. Record existing telephone cable.
2BM35356	1994	Communications	Columbia Cable of Washington	MP 307.99 - 308.38. 2" conduit with fiber-optic cable across Columbia River Bridge. Extends onto Washington side. Shown as a submarine crossing at lift span.
2BM35638	1996	Sewer	City of Portland	MP 307.16. 20" and 30" forcemain.
2BM35797	1997	Communications	TCI	MP 307.99 - 308.38. Temporary permit for installing fiber-optic cable on Columbia River Bridge. Extends onto Washington side.

Permit No.	Year Issued	Utility Type	Applicant	Comments
2BM35800	1997	Communications	All Phase Communications	MP 307.80 - 307.99. U/G fiber-optic cable.
2BM35801	1997	Communications	All Phase Communications	MP307.99 - 308.38. PVC conduits on Columbia River Bridge for fiber-optic cable. Extends onto Washington side, and includes vault and pull boxes.
2BM35831	1997	Communications	All Phase Communications	MP 307.46 - 307.70. Fiber-optic cable suspended under Oregon Slough Bridge.
2BM35873	1997	Communications	GST Telecom	MP 307.30. U/G fiber-optic cable. Mile Post is incorrect – cable located on Pier 99 Street.
2BM36005	1998	Water	City of Portland	MP 307.45. 8" DIP.
2BM36010	1998	Communications	Electric Lightwave	MP 307.48. O/H fiber-optic line on PP&L poles.
2BM36073	1999	Communications	Paragon Cable	MP 307.46 - 307.47. U/G fiber-optic & TV cable.
2BM36236	2000	Electricity	Portland General Electric	MP 308.00. U/G mainline backbone feeder.
2BM36242	2000	Electricity	Portland General Electric	MP 308.00. 4" & 6" U/G power conduit.
2BM36281	2000	Communications	Hayden Corner	MP 308.00. Replace traffic loop detector - loops not shown on drawings.
2BM36614	2002	Water	Doubletree Hotel	MP 308.00. Connection to ODOT water line. Insufficient information to verify location. Private connections not shown on the drawings.
2BM36829	2003	Communications	Qwest	MP 307.71. U/G 2" service conduit. Service connections not shown on drawings.
2BM37005	2005	Communications	Qwest	MP 307.71. U/G telephone cable.

Franchises and Permits Issued by WSDOT for I-5 Right-of-Way

Permit No.	Year Issued	Utility Type	Applicant	Comments
FRANCHISES				
	1994	Communications	Columbia Cable of Washington	MP 0.00 - 0.17. See ODOT Permit # 2BM35356.
	1997	Communications	All Phase Communications	See ODOT Permit # 2BM35801.
	1997	Communications	TCI	MP 0.00 - 0.23. See ODOT Permit # 2BM35797.
6423	1980	Electricity	Clark County PUD	MP 0.27. Existing 12.5kV O/H crossing. Franchise Agreement (expires 2005).
6423	1980	Electricity	Clark County PUD	MP O.53. Existing guy wire and neutral wire O/H crossing. Franchise Agreement (expires 2005). No longer there.
6423	1980	Electricity	Clark County PUD	MP 0.65. Existing 12.5kV O/H crossing. Franchise Agreement (expires 2005).
6423	1980	Electricity	Clark County PUD	MP 0.93. Existing 12.5kV O/H crossing. Franchise Agreement (expires 2005).
6423	1980	Electricity	Clark County PUD	MP 1.23. Existing 2 - 6" conduits without cable. Franchise Agreement (expires 2005).
6423	1980	Electricity	Clark County PUD	MP 1.82. Existing 12.5kV O/H crossing. Franchise Agreement (expires 2005).
6423	1980	Electricity	Clark County PUD	MP 2.02. Existing 69kV O/H crossing. Franchise Agreement (expires 2005).
6644	1984	Communications	Pacific Northwest Bell Telephone Co.	MP 0.54. O/H telephone cable crossing. Franchise Agreement (expires 2009). Crossing no longer exists.
6644	1984	Communications	Pacific Northwest Bell Telephone Co.	MP 0.84. O/H telephone cable crossing. Franchise Agreement (expires 2009). Crossing is on bridge.
6644	1984	Communications	Pacific Northwest Bell Telephone Co.	MP 1.55. U/G telephone cable crossing encased in a 30" steel pipe. Franchise Agreement (expires 2009.
6644	1984	Communications	Pacific Northwest Bell Telephone Co.	MP 1.56. U/G telephone cable crossing. Franchise Agreement (expires 2009).
6644	1984	Communications	Pacific Northwest Bell Telephone Co.	MP 1.98. O/H telephone cable crossing. Franchise Agreement (expires 2009). Crossing is actually at 33rd (MP 2.02).
6644	1984	Communications	Pacific Northwest Bell Telephone Co.	MP 0.29 - 0.32. U/G telephone cable crossing. Franchise Agreement (expires 2009).
6644	1991	Communications	Pacific Northwest Bell Telephone Co.	MP 1.55 - 1.62. U/G telephone cable crossing: within an existing duct. Franchise Agreement (expires 2009).
6644	1991	Communications	Pacific Northwest Bell Telephone Co.	MP 1.56 - 1.62. U/G telephone cable crossing: within existing ducts. Franchise Agreement (expires 2009).
40006	1985	Gas	Northwest Natural Gas Company	MP 0.25. 6" steel. Franchise Agreement (expires 2010).
40006	1985	Gas	Northwest Natural Gas Company	MP 1.28 - 1.29. 4" steel. Franchise Agreement (expires 2010).
40025	1987	Water	City of Vancouver	MP 0.25. 6" DIP. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 0.54 - 0.56. 12" DIP. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 0.58 - 0.60. 12" DIP. Franchise Agreement (expires 2012).

Permit No.	Year Issued	Utility Type	Applicant	Comments
40025	1987	Water	City of Vancouver	MP 1.00 - 1.04. 12" DIP. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 1.03 - 1.08. 8" pipe. Franchise Agreement (expires 2012). Partly abandoned.
40025	1987	Water	City of Vancouver	MP 1.03 - 1.04. 6" pipe. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 2.33 - 2.37. 8" DIP. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 2.36 - 2.38. 8" DIP with a 2" galvanized pipe. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 1.30. 20" DIP crossing not previously described. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 1.68. 6" pipe crossing in 36" culvert not previously described. Franchise Agreement (expires 2012). Abandoned.
40025	1987	Water	City of Vancouver	MP 1.83. 12" DIP crossing in 42" culvert not previously described. Franchise Agreement (expires 2012).
40025	1987	Water	City of Vancouver	MP 1.97. 10" DIP crossing in 42" culvert not previously described. Franchise Agreement (expires 2012).
40058	1988	Sewer	City of Vancouver	MP 0.26. Existing 8" CSP. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 0.43 - 0.44. Existing 8" CSP. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 0.44 - 0.45. Existing 8" CSP. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 0.56 - 0.58. Existing 33" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 1.03. Existing 8" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 1.08. Existing 8" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 1.19 - 1.26. Existing 10" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 1.30 - 1.37. Existing 8" pipe. Franchise Agreement (expires 2013). Abandoned.
40058	1988	Sewer	City of Vancouver	MP 1.68. Existing 14" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 1.68. Existing 12" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 2.25 - 2.29. Existing 8" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 2.29 - 2.34. Existing 8" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 2.34 - 2.35. Existing 27" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 2.31 - 2.37. Existing 8" pipe. Franchise Agreement (expires 2013).
40058	1988	Sewer	City of Vancouver	MP 2.41 - 2.44. Existing 12" pipe. Franchise Agreement (expires 2013).
40118	1994	Communications	Columbia Cable of Washington	MP 0.00 - 0.26. 2" duct with fiber-optic cable on Columbia River Bridge. Franchise Agreement (expires 2019).

Permit No.	Year Issued	Utility Type	Applicant	Comments
40118	1998	Communications	TCI	MP 0.00 - 0.26. 2" duct with fiber-optic cable. High level crossing of bridge lift span. Franchise Agreement (expires 2019).
40118	1998	Communications	TCI	MP 2.02. O/H fiber-optic cable crossing. Franchise Agreement (expires 2019).
40151	1997	Communications	Electric Lightwave	MP 0.26 - 0.27. O/H fiber-optic cable crossing. Franchise Agreement (expires 2022).
40151	1997	Communications	Electric Lightwave	MP 2.02. O/H fiber-optic cable crossing. Franchise Agreement (expires 2022).
40161	1998	Communications	GTE	MP 1.82. O/H fiber-optic cable crossing. Franchise Agreement (expires 2023).
PERMITS				
8828	1983	Communications	Cox Cable	MP 0.94. O/H CATV cable crossing. See #11072.
8842	1984	Communications	Cox Cable	MP 1.84. Two CATV cables within 29th Street structure.
8868	1983	Electricity	Clark County PUD	MP 0.66 - 0.69. 4" PVC duct with 12.5kV cable.
9749	1984	Communications	City of Vancouver	MP 1.03 - 1.05. U/G cable in PVC duct.
9278	1985	Communications	Cox Cable	MP 0.79 - 0.84. U/G CATV cable parallel to I-5 in 2" PVC duct.
11013	1994	Communications	Clark Public Utilities	MP 0.94 - 0.95. O/H fiber-optics cable lashed to neutral wire authorized under Franchise #6423.
11072	1995	Communications	Columbia Cable of Washington	MP 0.94. O/H CATV cable crossing.
11466	1996	Communications	TCI	MP 1.27 - 1.28. 2 - 2" PVC ducts. One is empty and one has a CATV cable.
U1196	2001	Communications	City of Vancouver	MP 1.03 - 1.05. U/G 3" duct with fiber-optic cable.
U1271	2002	Communications	Clark County Dept. of Information Technology	MP 0.85. 3 - 1.25" fiber-optic cable ducts.
U1315	2002	Communications	Clark Public Utilities	MP 0.26 - 0.28. O/H fiber-optic cable crossing.
U1444	2004	Communications	City of Vancouver	MP 1.58. Fiber-optic cables.

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APPENDIX L-4

Project Description – Initial Construction Program

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1. Project Description – Initial Construction Program (ICP)

1.1 General

The Record of Decision for the Columbia River Crossing Program identifies the transportation improvements of the selected alternative for the 5-mile project corridor, including:

- A new river crossing over the Columbia River and I-5 highway improvements.
- Improvements to seven interchanges, from south to north: Victory Boulevard, Marine Drive, Hayden Island, SR-14, Mill Plain, Fourth Plain and SR 500. Related enhancements to the local street network.
- Three new structures over North Portland Harbor associated with I-5, and one new multi-modal bridge carrying light rail transit, local traffic, pedestrians and bicyclists.
- A variety of bicycle and pedestrian improvements throughout the project corridor. A multiuse path connecting to the existing system. The path would allow users to travel from north Portland, over Hayden Island and the Columbia River into downtown Vancouver.
- Extension of light rail transit from the Expo Center in Portland to Clark College in Vancouver and associated transit improvements. Transit stations would be built on Hayden Island, in downtown Vancouver, and a terminus near Clark College. Three park and rides are to be built, Columbia (near the SR 14 interchange), Mill (in uptown Vancouver) and Central (near Clark College). Improvements would be made to the tracks on the Steel Bridge. Also, bus route changes and the expansion of the Ruby Junction light rail transit maintenance facility.
- Transportation demand and system management measures to be implemented with the project, including the use of tolls, subject to the authority of the Washington and Oregon Transportation Commissions.

(A detailed description of the selected alternative is included in Chapter 2 of the Final Environmental Impact Statement.)

The construction of the selected alternative will be phased to match available funding while providing significant transportation benefits. The first construction phase is referred to as the Initial Construction Program (ICP). The ICP includes the following multi-modal elements:

- The new river crossing over the Columbia River and the I-5 highway improvements, including improvements to three interchanges, as well as associated enhancements to the local street network.
- Extension of light rail from the Expo Center in Portland to Clark College in Vancouver, and associated transit improvements, including transit stations, park and rides, bus route and station changes, and expansion of a light rail transit (LRT) maintenance facility.
- Upgrades and modifications to the Steel Bridge and transit command center.
- Purchase of 19 light rail vehicles (LRV), public art and other transit-related procurements.

- Bicycle and pedestrian improvements throughout the project corridor that connect to the transit system.
- Toll system for the river crossing.
- Transportation demand and system management measures to be implemented with the project.

The ICP will require multiple construction contract bundles or packages (see attached figure). The following narrative contains a description of each construction package.

1.2 ICP Construction Packages (see attached figure)

1.2.1 River Crossing (RC)

- Construct new northbound and southbound bridges over the Columbia River. The existing Interstate (I-5) Bridge structures will be replaced by two parallel bridges slightly downstream and to the west of the existing crossing. The proposed bridge type is a composite deck truss in which the diagonal steel members allow for an open-sided, covered passage for the light rail guideway and multi-use path. The southbound bridge will carry highway traffic on the upper bridge deck with a two-way light rail guideway on the lower bridge deck. The northbound bridge will carry highway traffic on the upper bridge deck and a bicycle and pedestrian path on the lower deck.
- Construct LRT approach structures to the Columbia River Bridge from Hayden Island and Vancouver.
- On the lower deck of the southbound bridge, the Oregon LRT approach structure, and the Washington LRT approach structure, construct and install all transit civil, track, and systems components. All track on the main river bridge and approach structures will be direct fixation. The maximum grade will be 6%, on the Washington LRT approach structure from the BNSF crossing to touchdown at 5th Street and Washington Street in Vancouver.
- Construct the I-5 mainline from Columbia River Bridge to North Portland Harbor Bridge.
- Reconstruct ramp connections on the east and west sides of I-5 on Hayden Island in a configuration similar to the existing ramp connections.
- Reconstruct various local roads on Hayden Island.
- Reconstruct SR-14 connections to and from I-5 and downtown Vancouver.
- Construct a C Street entrance ramp to I-5.
- Reconstruct the I-5 mainline from the Columbia River Bridge to Evergreen Boulevard.
- Construct retaining walls on the east and west sides of the I-5 mainline.
- Construct a replacement Evergreen Boulevard Bridge over I-5.
- Construct the community connector over I-5 near the Evergreen Boulevard Bridge.
- Construct a replacement McLoughlin Boulevard Bridge with transitions on I-5 to accommodate the LRT that passes beneath I-5 at this point.
- Reconstruct portions of the Mill Plain Boulevard entrance ramp to I-5 southbound.
- Reconstruct portions of the I-5 northbound exit ramp to Mill Plain Boulevard.
- Reconstruct portions of Columbia Street, Columbia Way, Main Street, and 5th Street.
- Construct a shared-use path from the Columbia River Bridge to Columbia Way.
- Reconstruct portions of the southbound off-ramp to Fourth Plain Boulevard.

- Reconstruct portions of Fourth Plain Boulevard and the ramp terminal intersections on the east side of I-5.
- Construct an off-ramp from I-5 northbound to Fourth Plain Boulevard.
- Construct shared-use path connections from the Columbia River Bridge to connect to new and existing bicycle and pedestrian facilities on Hayden Island.

1.2.2 Bridge Removal (BR)

- Demolish the existing Interstate (I-5) Bridge structures.

1.2.3 Mainland Connector (MC)

- Elevate, realign, and reconstruct Marine Drive and modify the Marine Drive ramp terminal intersection and connecting ramps. Elevating Marine Drive provides a grade separation of the LRT from the local road mainland connector bridge to Hayden Island.
- Construct a mainland connector bridge to Hayden Island over North Portland Harbor. The North Portland Harbor (NPH) multimodal bridge will accommodate local vehicle traffic, LRT, and bicycle and pedestrian facilities and will connect to a new local street on Hayden Island and to N. Expo Road on the mainland.
- Construct a new driveway on the extension of N. Expo Road as a replacement access point for Diversified Marine Inc. and Ross Island Sand and Gravel.
- Realign the shared-use path adjacent to North Portland Harbor to go over the LRT line and the connecting street between the mainland and Hayden Island, running parallel and adjacent to Marine Drive. On either side of the grade separation, the path will reconnect to the existing path.

1.2.4 Marine Drive (MD)

- Construct a new single point interchange at Marine Drive and I-5 and associated ramps. This will require demolition of the existing structure that crosses I-5 and construction of a new structure over I-5 to carry Marine Drive. The Marine Drive alignment constructed with the mainland connector bridge will be adjusted in grade and alignment to match the new single point interchange. (Note: The MC package will be constructed first. The alignment of Marine Drive in the vicinity of the LRT and the local road will be slightly adjusted in the MD package. The structures constructed in the MC for the LRT and the local road will remain, with no disruption to light rail or traffic operations.)
- Reconstruct the connections from Marine Drive to Union Court and from Vancouver Way to Marine Drive.
- Construct a road on the south end of the Expo Center between North Expo Road and Force Avenue and thus provide a local route between Hayden Island and Marine Drive.
- Widen I-5 southbound from the North Portland Harbor bridge to a point just south of the Victory Boulevard crossing to provide an additional lane.
- Widen I-5 northbound from the Victory Boulevard crossing to the North Portland Harbor Bridge to accommodate the northbound Denver Street entrance ramp as an auxiliary lane.
- Re-stripe I-5 and reallocate the width of the North Portland Harbor bridge to allow for an additional southbound lane.
- Relocate the function of the North Portland Harbor shared-used path to the sidewalk and bike lanes on the new mainland connector multimodal bridge.

1.2.5 Oregon Transit (OT)

- Construct a double-track LRT guideway to extend from the existing Expo Center MAX station to the new multimodal mainland connector bridge over the North Portland Harbor and across Hayden Island. There will be accommodation for an at-grade crossing at Vancouver Way, a new street that is part of the larger Columbia River Crossing Program. This signalized crossing will include a signal gate on both the eastbound and westbound intersection approaches. On Hayden Island, the LRT guideway will be partially on fill and partially on structure. The alignment will be roughly parallel to the I-5 alignment. On the north end of Hayden Island, the light rail alignment will rise in elevation on structure until it transitions onto the lower deck of the new westernmost bridge (southbound I-5) over the Columbia River. The total distance of the LRT guideway between the Expo MAX station and the Columbia River Bridge approach structure is just over a half-mile.
    - The grade of the track upon leaving the Expo MAX Station will be 6%. On the NPH bridge, the grade from the south abutment to the approximate midpoint will be 5%, and then the grade will be 2% as the alignment descends to Hayden Island, before flattening out through the station and ultimately transitioning to the lower deck of the main river crossing bridge (with a maximum grade of 1%).
    - The exclusive (LRV only) guideway is a mix of ballasted track and direct fixation (on structure) from the Expo MAX station to the lower deck of the main river crossing bridge. At Vancouver Way, ballasted track with modular grade crossing panels will be constructed.
- Construct a bridge over the A Street to I-5 South (A-5S) on-ramp and to accommodate the future Tomahawk Island Drive.
- Build the Hayden Island transit station on structure as a center platform station providing the following amenities:
    - Minimum platform length of 200 feet and platform width of ±20 feet
    - A covered ticket vending machine at each platform access
    - Wind shelter and canopy incorporated into the structure as well as standard amenities, signage, and public art
    - Elevator, ramps, and stairs for access to and from adjacent roadways

1.2.6 Washington Transit (WT)

- At the beginning of the LRT alignment in Washington, at the intersection of Washington Street and 5th Street, install a signal gate for both eastbound and westbound vehicle traffic. The double-track LRT guideway will be in the center of the street between 5th and 7th Streets. The intersections at 6th Street and Washington Street and 7th Street and Washington Street will be signalized (both traffic and LRT). At 7th Street, the light rail alignment will transition to a couplet, with the northbound guideway on the west side of Broadway Street and the southbound guideway on the east side of Washington Street. At 17th Street, the two guideways will join and turn east for approximately nine blocks. At G Street, the guideway on 17th Street will angle north one block to McLoughlin Boulevard. There will be a signal gate on McLoughlin Boulevard for eastbound traffic. The guideway will then cross under I-5 to run down the center of McLoughlin Boulevard to the Central Park terminus station and park-and-ride structure east of I-5.

- Convert 7th Street to one-way traffic eastbound between Washington and Broadway Streets, with traffic and interconnected LRT signals installed at Main Street and Broadway Street. The profile grades along 7th Street will vary from 0% to 5%.
- Convert Broadway Street to two-lane traffic northbound, with traffic and interconnected LRT signals installed at 8th, 9th, Evergreen, 11th, 12th, 13th, Mill Plain, 15th, 16th, and 17th Streets. The LRT guideway will be constructed on the west side of Broadway Street, with the profile grades along Broadway Street varying from 0% to 5%.
- On 17th Street, construct the double-track LRT guideway to run down the center of the street, with eastbound traffic on the south side of the street and westbound traffic on the north side of the street. Profile grades along 17th Street vary from 0% to 4%. Traffic and interconnected LRT signals will be installed at intersections with Washington, Main, C, D, E, and F Streets.
- On McLoughlin Boulevard, roughly in between the I-5 underpass and a new station to the east, construct the double-track LRT guideway to run down the center of the street, with eastbound traffic on the south side of the street and westbound traffic on the north side of the street. Profile grades on McLoughlin Boulevard will vary from 0% to 5%. There will be a traffic and interconnected LRT signal installed at the entrance to the Central Park and Ride.
- On Washington Street, construct the guideway on the west side of the street, with traffic and interconnected LRT signals installed at 16th, 15th, Mill Plain, 13th, 12th, 11th, Evergreen, 9th, 8th, and 7th Streets. The profile grades on Washington Street will vary from 1% to 5%.
- All track in Washington will be embedded t-rail.
- Construct LRT stations, designed not to preclude BRT, along the transit guideway at:
    - 6th and Washington Street Station – located within vacated Washington Street between 5th and 6th Streets, and servicing the Columbia Park and Ride (see section 1.2.6, below). This station shall have co-located side platforms with northbound and southbound rail between them. The platforms shall provide:
        - A minimum platform length of 190 feet and a minimum platform width of 12 feet.
        - A covered ticket vending machine at each platform access.
        - Two shelters per platform with standard amenities, signage, and public art.

    - Evergreen and Broadway Platform – located on the west side of Broadway Street between 9th Street and Evergreen Street
    - 16th and Broadway Platform – located on the west side of Broadway Street between 15th Street and 16th Street
    - 9th and Washington Platform – located on the east side of Washington Street between 9th Street and Evergreen Street
    - 15th and Washington Platform – located on the east side of Washington Street between 15th Street and 16th Street. This platform adjoins and provides access to the Mill Park and Ride.
    - These platforms shall provide:
        - A minimum platform length of 190 feet (200 feet at 15th Street and Washington Street) and a minimum platform width of 12 feet.
        - An adjacent sidewalk of 7.5 feet.
        - A covered ticket vending machine at each platform access.

        - Two shelters per platform with standard amenities, signage, and public art.

    - Central Station – located at the end of line on McLoughlin Boulevard. This station provides access to the Central Park and Ride and a major bus transfer location and has a center platform. The platform shall provide:
        - A minimum platform length of 200 feet and a minimum platform width of 17.5 feet.
        - A covered ticket vending machine at each platform entrance and accommodation for future covered vending machines at or near the park-and-ride structure.
        - Four shelters per platform with standard amenities, signage, and public art.

- Construct full-block bus stops along the LRT alignment or adjacent to significant developed improvements at the following locations:
    - 7th and Main Streets.
    - Broadway and 9th Streets.
    - Broadway and Evergreen Streets.
    - Broadway and 13th Streets.
    - Broadway and 16th Streets.
    - Main and 15th Streets.
    - Washington and 12th Streets.
    - Washington and 8th Streets.
    - Central Station.
- Construct two surface parking lots, at SR-14 and at 5th Street (Smith Tower). The SR-14 lot will be located within the perimeter of the SR-14 on-ramp to I-5 North and will contain approximately 50 stalls. The 5th Street lot will be located north of 5th Street and east of the 6th and Washington Street LRT station. This lot is a reconstruction of an existing parking lot at the same location and will contain a minimum of 17 stalls.

1.2.7 Park and Rides (PR)

- Construct three park-and-ride garages, distributing a minimum of 2,900 spaces, needed for the project based on ridership demand models, as follows:
    - Columbia Park and Ride – located between Columbia Street and Washington Street and between 4th Street and 5th Street, and includes retail/office space frontage facing Columbia Street. Primary ingress and egress is on 5th Street at the north end of the structure. This park and ride will provide approximately 570 auto parking spaces and 34 bicycle parking spaces, and will have five floors and an exposed height of 68.5 feet.

    - Mill Park and Ride – located between 15th and 16th Streets and between Washington Street and Main Street, and includes retail/office space frontage on both Main Street and Washington Street. Washington Street will also have a C-TRAN Customer Service Center and parking on 16th Street to accommodate paratransit vehicles. Vehicles can enter from 15th and 16th Streets, but can exit only onto 16th Street. This park and ride will provide approximately 420 auto parking spaces and 30 bicycle parking spaces, and will have five floors and an exposed height of approximately 60 feet.

  - Central Park and Ride – located east of I-5, north of McLoughlin Boulevard, and across from the Marshall Community Center. One access is provided via a loop road, which provides direct access to and from Fourth Plain Boulevard and the I-5 access ramps at the interchange. The loop road wraps around the east side of the building and passes through the south end of the garage before returning north to Fourth Plain Boulevard. The garage can also be accessed via an entrance from McLoughlin Boulevard. This park and ride will provide approximately 1,910 auto parking spaces and 81 bicycle parking spaces, and will have five floors and an exposed height of 55.5 feet. A C-TRAN shared safety and security and Vancouver police mini-station will be included at this location as well as an operator break room located outside of the structure near the terminus station.
- Construct access roads and two bridges near the Central Park and Ride to grade-separate ingress and egress to the parking facility.

1.2.8 Transit Systems (TS)

- The Transit Systems package will provide power, signalization, and communications capability along the entire light rail alignment and will be composed of the following primary system elements:
  - 2.9 miles of light rail extension (power, signals, and communications infrastructure) of the existing MAX system.
  - Three new 1-megawatt substations and three new combined signals/communications buildings at the following locations:
    - Next to Hayden Island Station off Tomahawk Island Drive.
    - Southeast of 6th Street/Washington Avenue Station near the 5th Street parking lot.
    - Near the intersection of 17th and G Streets just south of McLoughlin Boulevard.
  - One communications room inside the Mill Park and Ride.
  - One signals room inside the Mill Park and Ride.

1.2.9 Transit Other (TO)

1.2.9.1 Ruby Junction Yard and Maintenance Facility Expansion

- To accommodate storage of the 19 additional light rail vehicles (LRVs) associated with the ICP, the Ruby Junction Yard and Maintenance Facility in Gresham, Oregon, will be expanded. This expansion will be in conjunction with an existing expansion project to accommodate additional LRVs as part of the Portland Milwaukie Light Rail (PMLR) project. Improvements include storage for the new LRVs and other maintenance material, expansion of LRV maintenance bays, and expanded parking for additional personnel.

1.2.9.2 Steel Bridge Modifications

- The Steel Bridge, located near the Rose Quarter in downtown Portland, carries all of the light rail transit lines within TriMet’s system over the Willamette River. To accommodate the additional LRVs associated with the ICP, the Steel Bridge will be modified to increase throughput over the bridge by raising the maximum crossing speed of LRVs from 10 miles per hour to 15 miles per hour. Specifically, the modifications are as follows:

- Grind the transit rails within the track bed to remove the lift joint bumps, rail corrugation, and any rough field welds.
- Install a vibration pad under the existing signal case on the lift span to dissipate vibration.
- Stiffen the overhead catenary system brackets to allow for greater impact as the catenary transfers from the fixed span to the movable span.
- Adjust signals for light rail transit and traffic at NW Everett Street and N Interstate Avenue to accommodate higher speeds.

1.2.9.3 Light Rail Vehicle Procurement

- To accommodate the additional passengers that have been identified for the ICP, 19 new LRVs will be procured. This procurement is planned to use an option clause associated with the PMLR project.

1.2.9.4 Command Center Upgrades/Modifications

- The TriMet command center at SE Center Street in Portland will be upgraded and modified to account for the light rail extension to Vancouver. This will include a number of hardware and software upgrades to the existing train control system.

1.3 Tolling

- Tolling cars and trucks that use the I-5 river crossing will be used to help fund the ICP and to encourage the use of alternative modes of transportation. A variable toll will be applied on vehicles using the I-5 crossing. Tolls will vary by time of day, with higher rates during peak travel periods and lower rates during off-peak periods. Medium and heavy trucks will be charged a higher toll than passenger vehicles. Tolls will be collected using an electronic toll collection system, so that toll collection booths will not be required.

1.4 Transportation Demand Management and Transportation System Management

- Implement physical features and operational elements as part of the Columbia River Crossing Program that enhance opportunities for the region to achieve its Transportation Demand Management (TDM) goals by promoting other modes to fulfill more of the travel needs in the project corridor. These include:
  - A new light rail line with connections to express bus and feeder routes operated by C-TRAN and TriMet.
  - Modern bicycle and pedestrian facilities that accommodate more bicyclists and pedestrians, and that improve connectivity, safety, and travel time.
  - Park-and-ride facilities.
  - A variable toll on the highway crossing.

- Implement facilities and equipment that could help existing or expanded Transportation System Management (TSM) programs maximize the capacity and efficiency of the system. These could include:
    - Replacement or expanded variable message signs or other traveler information systems.
    - Continued incident response capabilities.
    - Expanded traveler information systems with additional traffic monitoring equipment and cameras.

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Figure 1.0. Wetlands and Stormwater Treatment Facilities - Oregon

Source: Locally Identified Wetlands = Clark Co. and Metro; Project Delineated Wetlands = Columbia River Crossing (Parametrix)

Analysis by J. Koloszar; Analysis Date: 31 Oct 2012; File Name: Exhibit3_6_3_8_TF255.mxd

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W E
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0 130 260
Feet

ICP Project Footprint
ICP Stormwater Treatment Facilities
Vanport Wetlands Mitigation Area
Wetland Areas
Potentially Jurisdictional Water Area (PJWA)
Outfalls and Culverts
Dry Stormwater Feature

Figure 2.0. Wetlands and Stormwater Treatment Facilities - Oregon

Source: Locally Identified Wetlands = Clark Co. and Metro; Project Delineated Wetlands = Columbia River Crossing (Parametrix)

Analysis by J. Koloszar; Analysis Date: 31 Oct 2012; File Name: Exhibit3_6_3_8_TF255.mxd

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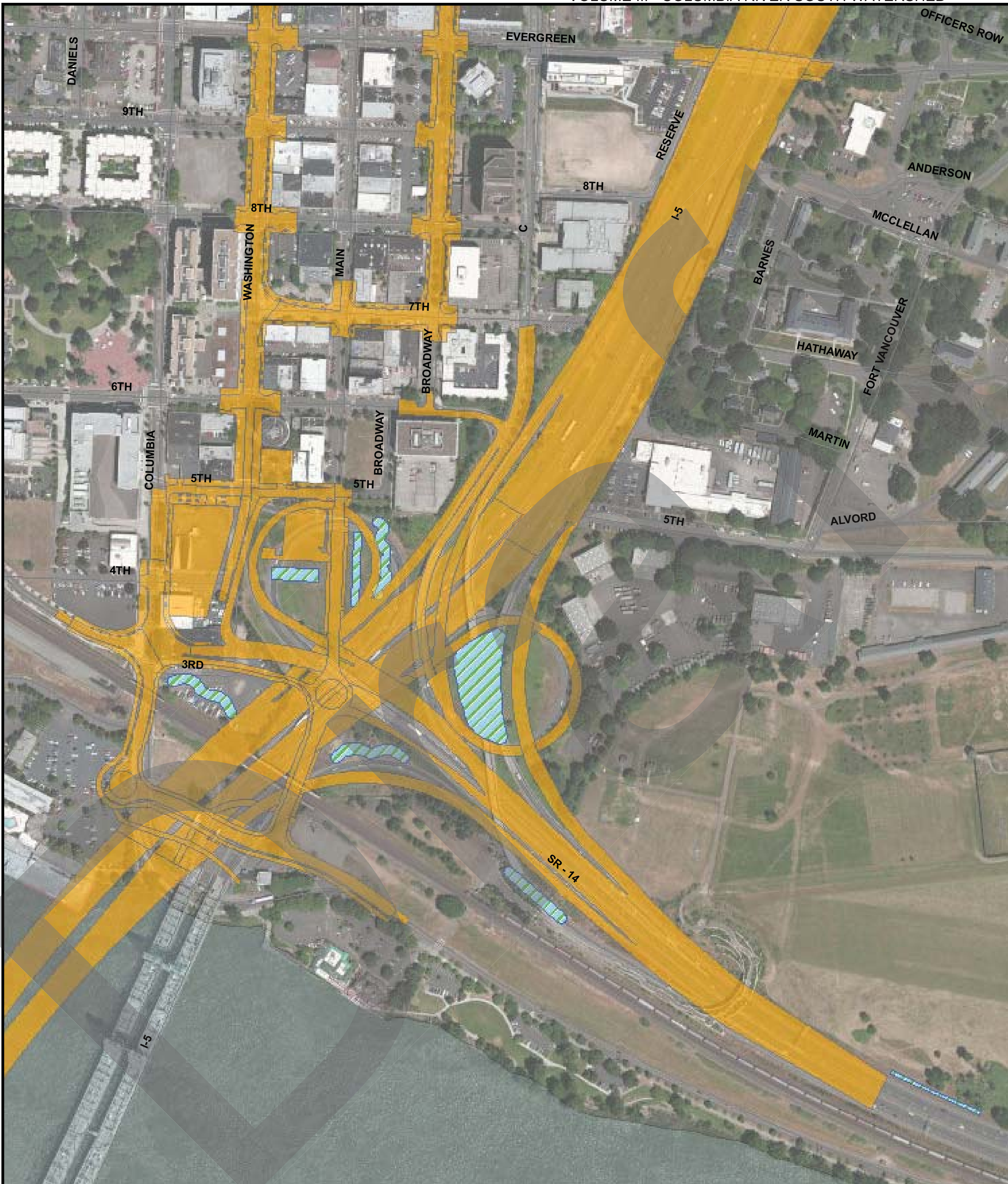

ICP Project Footprint
ICP Stormwater Treatment Facilities
Vanport Wetlands Mitigation Area
Wetland Areas
Potentially Jurisdictional Water Area (PJWA)
Outfalls and Culverts
Dry Stormwater Feature

0 170 340
Feet

Figure 3.0. Wetlands and Stormwater Treatment Facilities - Washington

Columbia River CROSSING

Source: Locally Identified Wetlands = Clark Co. and Metro; Project Delineated Wetlands = Columbia River Crossing (Parametrix)

Analysis by J. Koloszar; Analysis Date: 31 Oct 2012; File Name: Exhibit3_6_3_8_TF255.mxd

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ICP Project Footprint
ICP Stormwater Treatment Facilities
Vanport Wetlands Mitigation Area
Wetland Areas
Potentially Jurisdictional Water Area (PJWA)
Outfalls and Culverts
Dry Stormwater Feature

N W E S

0 170 340
Feet

Figure 4.0. Wetlands and Stormwater Treatment Facilities - Washington

Columbia River CROSSING

Source: Locally Identified Wetlands = Clark Co. and Metro; Project Delineated Wetlands = Columbia River Crossing (Parametrix)

Analysis by J. Koloszar; Analysis Date: 31 Oct 2012; File Name: Exhibit3_6_3_8_TF255.mxd

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