Technical Information Report

Conditional Use Permit Submittal

PREPARED FOR:

Rolluda Architects
105 South Main Street, Suite 323
Seattle, WA 98104

PROJECT:

Tukwila Elementary School Addition
5939 South 149th Street
Tukwila, WA 98168
Parcel No. 3597000120
AHBL No. 2180149.10

PREPARED BY:

Casey Jeszeck, EIT
Project Engineer

REVIEWED BY:

Douglas G. Tapp, PE
Principal

Charlie Palmer, PE
Project Manager

DATE:

January 2019

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I hereby state that this Technical Information Report for the Tukwila Elementary School Addition project has been prepared by me or under my supervision, and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that City of Tukwila does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

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(No Attachments)

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Section 1

Project Overview

1.0 Project Overview

1.1 Purpose and Scope

This report accompanies the civil engineering plans and documents for the Tukwila Elementary School Addition project located on Parcel No. 3597000120 in King County, Washington. The parcel is approximately 11.24 acres in total size and the area affected by redevelopment is approximately 0.52 acre. Refer to Exhibit 1-2 for a Vicinity Map.

The new improvements include construction of a two-classroom modular addition with a new corridor, new overflow parking north of the existing parking lot, additional parking north of the west bus drop-off, and an upgraded Early Learning play area in the southeast corner of the existing school building. Stormwater management will comply with the 2016 King County *Surface Water Design Manual (KCSWDM)*, as adopted by City of Tukwila.

1.2 Existing Conditions

The existing site is developed with asphalt-paved parking lots and driveways, an asphalt-paved playground and play area, a school building, concrete covered sidewalks, and vegetated areas. Access to the site is from the South 149th Street right-of-way.

The site has roughly 34 feet of fall across the developed portion of the site, with the highest point along the northern boundary at roughly 198 feet, and the lowest point along the southern boundary at roughly 164 feet. The site also has a general slope from the northwest to the southeast of the site. The existing 12-inch storm main running along the north face of the school building provides stormwater collection for the north and east sides of the parcel and daylights at the north end of the biofiltration swale that lies along the east boundary of the parcel. Another 18-inch existing main storm drain running along the back side of the building conveys stormwater that generates in the west and south portions of the parcel. A 36-inch CMP pipe runs parallel to the 18-inch storm drain, collecting roof runoff from the existing school building, and then joins the storm main in the southwest corner of the parcel. These structures convey the stormwater to the manhole structure in the southeastern corner of the parcel that flows offsite (see Exhibit 1-3, Existing Conditions Map). All structures connect to a storm system leading water south offsite, leading to the Green River; therefore, the project site is part of a single Threshold Discharge Area (TDA).

According to the USGS (Exhibit 1-5), the site soils consist of Glacial Till (Qvt) and Tertriary Renton Formation (Tpr). A geotechnical report was created by Shannon & Wilson, Inc. on August 27, 2018, providing additional soil information (see Exhibit 6-1).

1.3 Post-Development Conditions

The project proposes to construct a new bus queueing and overflow parking area, a new expanded overflow parking area, a two-classroom modular addition, and an upgraded play area. Improvements also include demolition and replacement of the existing vegetated area west to the existing bus drop-off, as well as the area north to the exiting east parking; adding the modular classrooms onto the existing school building; and extension of the existing play area with new paving and equipment.

The project site area around the school is 0.52 acre, with 0.33 acre of new and replaced impervious area, which is delineated on Exhibit 1-4, Developed Conditions Map. The replaced impervious surface exceeds 5,000 square feet; therefore, Core Requirement 3: Flow Control Facilities are required. Runoff from the site is divided between the new detention facilities and the existing storm system. Approximately 0.52 acre of the site will be discharged to the new flow control facilities. The remainder of the site will be collected by the existing storm system.

Runoff generated on the surface of the new modular classrooms will discharge to the surface of the raised bioretention planter, and then be retained by the 36-inch CMP detention pipe underneath. Refer to Exhibit 5-1 for clarification (to be provided).

Stormwater improvements will include adding two detention facilities, one sloped bioretention facility, one compost amended vegetated filter strip, above-grade bioretention planters, storm pipes, and catch basins.

The project site's developed drainage patterns are analyzed and discussed in further detail in Section 4.0, Flow Control and Water Quality Facility Analysis and Design.

Section 2

Conditions and Requirements Summary

2.0 Conditions and Requirements Summary

2.1 Conditions of Approval

Conditions of Approval will be included in the final Technical Information Report, as required.

2.2 Core Requirements

2.2.1 CR 1 – Discharge at the Natural Location

All stormwater runoff will be discharged at a natural location or infiltrate onsite. In the existing conditions, stormwater runoff sheet flows to catch basins that drain to an existing system, which conveys the water running along the existing building faces south offsite, flowing southerly through the Gilliam Basin before being discharged into Gilliam Creek, and then to the Green River. In the developed condition, part of the site will be collected and directed to new detention facilities, and the remainder will use the existing bypass system, meeting Core Requirement 9. The existing system ultimately discharges to the Green River approximately 0.85 mile from the site.

2.2.2 CR 2 – Offsite Analysis

The primary discharge location for the school area of the project site is from a catch basin located at the southeast corner of the property. This structure hydraulically connects to the existing storm system located in the southeast portion of the site area. In the developed condition, the storm runoff sheet flows to bioretention or a vegetated filter strip that is followed by a new underground detention facility, and then discharges to the existing storm system. Refer to Exhibit 3-3 for a map and description of the downstream drainage system.

2.2.3 CR 3 – Flow Control

The Tukwila Elementary School site is required to provide flow control because more than 5,000 square feet of new plus replaced impervious surface will be created. The project proposes to construct two underground detention systems in the parking area to meet the flow control requirement. Refer to Exhibit 1-4, Developed Conditions Map, for the locations of the proposed detention facilities. The design and calculations for the detention system are included in Section 4.0.

2.2.4 CR 4 – Conveyance System

Conveyance systems will be designed and analyzed per Chapter 4 of the *KCSWDM*. New facilities will be designed to convey as much as 25-year peak flow. The design and calculations for the conveyance system will be included in Section 5.0 of the final report.

2.2.5 CR 5 – Erosion and Sediment Control

An erosion and sediment control plan was developed for this site in accordance with the *KCSWDM* and the *King County Stormwater Pollution Prevention Manual (KCSPPM)*. The full erosion and sediment control plan is described further in Section 8.0 and in the project plans.

2.2.6 CR 6 – Maintenance and Operations

The onsite drainage facilities will be privately maintained by Tukwila School District. An Operations and Maintenance Plan is provided in Section 10.0.

2.2.7 CR 7 – Financial Guarantees and Liability

A Bond Quantity worksheet is not required, per Washington Administrative Code, as a public agency cannot collect construction bonds from publicly funded projects.

2.2.8 CR 8 – Water Quality

Runoff generated by the new and replaced pollution-generating impervious area will sheet flow to a vegetated filter strip, and will discharge to the detention facility through perforated underdrains. Above-grade bioretention planters are proposed to provide maximum filtration to the roof drain of the new modular addition and corridors.

2.2.9 CR 9 – Flow Control BMPs

Flow Control Best Management Practices (BMPs) have been evaluated to meet the core requirements. The project falls under the requirements for Large Lot BMP (see Section 4.0).

2.3 Special Requirements

2.3.1 SR 1 – Other Adopted Area-Specific Requirements

The project site discharges to the Green River approximately 0.85 miles downstream from the project site. The Green River water quality holds the following status:

Category 5 – 303(d) Water:

- Dissolved Oxygen

Category 4A/4C Water:

- Temperature; Large Woody Debris

Category 2 Water:

- Bis(2-Ethylhexyl) phthalate; PCBs; Mercury; Toxaphene; Endrin; pH; Dissolved Oxygen; Bacteria

Category 1 Water:

- Ammonia-N; Bacteria; Arsenic; Copper; Selenium

The project will not adversely affect any of the assessed issues per the Clean Water Act.

2.3.2 SR 2 – Floodplain/Floodway Delineation

Flood Insurance Rate Map No. 53033C0957F, Panel 957 of 1725, was consulted for this project and did not show any floodplains on the project site. Refer to Exhibit 3-6 for the Floodplain Map.

2.3.3 SR 3 – Flood Protection Facilities

The project does not contain, will not construct, and is not adjacent to any existing flood protection facilities.

2.3.4 SR 4 – Source Controls

The proposed project consists of a modular building addition, an expanded parking lot and Early Learning play area, and some minor repaving. The *KCSPPM* will be referenced for source control measures in addition to erosion and sediment control measures during construction. For construction source controls, see Section 8.0, CSWPPP Analysis and Design. For post-construction source controls, see Section 10.0, Operations and Maintenance Plan.

2.3.5 SR 5 – Oil Control

The project does not fit the definition of a high-use site; therefore, it is not subject to oil control requirements.

Section 3

Offsite Analysis

3.0 Offsite Analysis

3.1 Task 1 – Define and Map the Study Area

The project site for Tukwila Elementary School is located on the south side of South 149th Street (Parcel 3597000120). The parcel is surrounded by 58th Avenue South to the west, and single-family residential developments to the south and east. Refer to Exhibit 3-1 for a Vicinity Map. The site contains one TDA, which is consistent with the topographic and existing conditions shown in the survey.

The existing school area consists of classroom structures, an asphalt paved bus drop-off, parking lots, playground, play area, concrete walkways, and vegetated areas. Stormwater facilities include a biofiltration swale followed by a detention pond; and an underground detention pipe system with flow control devices, which serves to provide water quality for the roof runoff generated on the surface of the existing school building. Two main conveyance pipes onsite run relatively parallel to the building faces. The northern pipe discharges to the north end of the biofiltration swale. Runoff flows though the biofiltration swale and overflows to the outlet control structure. Flow then meets the southern pipe at the south side of the existing detention pond. The downstream analysis begins at this point, where a manhole structure is located in the middle of the pathway.

The field inspection (Task 3) of the qualitative downstream analysis was performed on August 23, 2018, starting with the structure mentioned above.

The downstream system was walked for approximately 0.50 mile to document the existing conditions and to perform the tasks detailed below.

See the attachments at the end of this report for maps, photos, and the Offsite Analysis Drainage System Table (Exhibits 3-3 through 3-5).

3.2 Task 2 – Review All Available Information on the Study Area

The following resources were reviewed to discover any existing or potential problems in the study area:

- Adopted Basin Plans: The project site is located within the Gilliam Drainage Basin, as identified by the City of Tukwila 2013 *Surface Water Comprehensive Plan* (see Exhibit 3-8).
- Floodplain/Floodway (FEMA) Maps: The project site is classified as Zone X per FEMA Flood Insurance Rate Map # 53033C0957F, revised May 16, 1995, which determined the site to be located outside the 500-year floodplain (see Exhibit 3-6).
- Sensitive Areas Folio: Refer to Exhibit 3-7 for the Sensitive Areas Folio Map. The project site does not contain any landslide, erosion, seismic, or coalmine hazard areas.
- Department of Natural Resources and Parks (DNRP) Drainage Complaints: No drainage complaints are listed on the DNRP that are younger than 10 years in the study area.
- Road Drainage Problems: No drainage problems were identified.
- USDA Soils Survey: See Exhibit 1-5 for the Soils Survey Map. Soil in the project area was identified as Glacial Till (Qvt) and Tertriary Renton Formation (Tpr).

- Wetlands Inventory: The U.S. Fish and Wildlife Service National Wetlands Inventory was used to determine the presence of wetlands within the downstream area. No wetlands are shown within 1 mile downstream of the project site (see Exhibit 3-9).

- Migrating River Studies: Green River is located nearly 0.85 mile downstream of the project site, which is not classified as a channel migration hazard area.

- Other Offsite Analysis Reports: Gilliam Creek Basin Stormwater Management Plan prepared by Herrera Environmental Consultants, Inc. in 2001 (see Exhibit 6-2) indicates that the only reach of Gilliam Creek that is accessible to anadromous fish is located along the south shoulder of I-405 between the Green River and I-5, which is roughly 1 mile downstream of the site. However, access to the lower reach for anadromous fish is very limited.

- Section 303(d) List of Polluted Waters: According to the map, there is a Category 5 waterbody at the outlet of the downstream analysis approximately 1 mile from site. The Category 5 waterbody is the Green River (see Exhibit 3-10 for a copy of the area map).

- King County Designated Water Quality Problems: Per current *KCSWDM Reference Section 10*, there are currently no known identified water quality problems.

- Stormwater Compliance Plan: An adopted stormwater compliance plan has not been identified with DNRP Water and Land Resources Division.

- City of Tukwila Drainage Complaint: Based on emails with Ryan Larson, Senior Program Manager – Surface Water, there are no evident stormwater complaints in the areas surrounding the project site.

3.3 Task 3 – Field Inspect the Study Area (Level 1)

A Level 1 (qualitative) downstream field inspection was completed on August 23, 2018. The weather was slightly smoky, with temperatures around 70 degrees. The site was dry with no sign of ponding or erosion.

The Level 1 inspection included the following tasks:

1. *Investigate any problems reported or observed during the resource review.*

    o No reported or observed problems concerning drainage or flooding were identified during the site visit.

2. *Locate all existing/potential constrictions or lack of capacity in the existing drainage system.*

    o No existing or potential constrictions or lack of capacity were identified downstream of the project area.

3. *Identify all existing/potential downstream drainage problems as defined in KCSWDM Section 1.2.2.1.*

    o No existing drainage problems were identified downstream of the project area.

4. *Identify existing/potential overtopping, scouring, bank sloughing, or sedimentation.*

    o None of these problems was identified during field inspection.

5. *Identify significant destruction of aquatic habitat or organisms.*

    - No areas of significant destruction were identified, including siltation, bank erosion, or incision in a stream.

6. *Collect qualitative data on features such as land use, impervious surfaces, topography, and soil types*.

    - Data reviewed during resource review was confirmed during the field inspection.

7. *Collect information on pipe sizes, channel characteristics, drainage structures, and relevant critical areas*.

    - This information is identified in Task 4.

8. *Verify tributary basins delineated in Task 1.*

    - Tributary basins confirmed from Task 1.

9. *Contact neighboring property owners or residents in the area about past or existing drainage problems, and describe these in the report.*

    - No drainage problems were shown on King County's iMap viewer relating to the drainage basin.

10. *Note the date and weather conditions at the time of inspection.*

    - Noted above.

3.4 Task 4 – Describe the Drainage System, and its Existing and Predicted Drainage and Water Quality Problems

The field inspection included walking the downstream flow path from the site's south discharge location to approximately 0.50 mile downstream. The Offsite Analysis Map, Offsite Analysis Drainage System Table, and photos from the field inspection are provided on Exhibits 3-3, 3-4, and 3-5, respectively. Refer to the written description of the downstream drainage system given below.

The field inspection began at Element A, which is a 12-inch CMP outlet with bar screening in the end, followed by a rock pad for energy dissipation. Water flows to Element B through surface sheet flow. Refer to Element A in the enclosed documents for location, photos, and drainage systems table.

Element B is a vegetated biofiltration swale. Runoff infiltrates through amended soil while flowing through the wetland, and then enters Element C. Refer to Element B in the enclosed documents for location, photos, and drainage systems table.

Element C is a round-shaped detention pond with approximately 3:1 side slope, which accepts water overflowing from Element B. Water flows out through a 12-inch riser located in the southeast corner and enters Element D. The pond is dry and in good condition. Refer to Element C in the enclosed documents for location, photos, and drainage systems table.

Element D is a locked lid Type 2 catch basin that has 12-inch CPEP flowing in with an overflow weir on top. The outflow pipe is a 12-inch CMP constructed with vertical riser and rectangular notch weir as a flow control structure. Shear valve is also installed for this pipe for emergency flow. Refer to Element D in the enclosed documents for location, photos, and drainage systems table.

Element E is a Type 2 catch basin with vane grate in good condition, having one 12-inch and one 18-inch CPEP flowing in and one 24-inch CPEP flowing out. Refer to Element E in the enclosed documents for location, photos, and drainage systems table.

Element F is a Type 1 catch basin with vane grate in good condition, having one 12-inch and one 24-inch concrete pipe flowing in and one 24-inch concrete pipe flowing out. Refer to Element F in the enclosed documents for location, photos, and drainage systems table.

Element G is an estimated 24-inch concrete pipe that daylights to a narrow channel. This channel flows parallel to the trail that is located between South 151st Street and South 153rd Street, and then becomes a wetland around the residential area. Refer to Element G in the enclosed documents for location, photos, and drainage systems table.

Element H is a Type 1 catch basin with vane grate in good condition, having one 24-inch concrete pipe flowing in and two 12-inch concrete pipes flowing out. Refer to Element H in the enclosed documents for location, photos, and drainage systems table.

Element I is a Type 2 manhole with an estimated 24-inch concrete culvert pipe flowing in and out. The flow is discharged to an open channel south of South 153rd Street. Water then travels south between residential developments for approximately 0.15 mile and crosses Southcenter Boulevard and I-405 through culvert pipe near 62nd Avenue South. Refer to Element I in the enclosed documents for location, photos, and drainage systems table.

Drainage Problem Review

1. *Description of the problem*.

    - None identified.

2. *Magnitude of damage caused by the drainage problem*.

    - No damage was observed. There was no sign of erosion, sedimentation, flooding, or significant destruction of aquatic habitat or organisms.

3. *General frequency and duration of drainage problem.*

    - There have been no reported complaints regarding this location.

4. *Return frequency of storm or flow of the water when the problem occurs (option for level 1).*

    - Frequency and duration of the drainage problems have not been reported.

5. *Water surface elevation when problem occurs*.

    - No water was observed to be backing up onsite or at the outlet location at Gilliam Creek.

6. *Names and concerns of involved parties (optional).*

   - No involved parties have identified a concern.

7. *Current mitigation of drainage problem.*

   - None identified.

8. *Possible cause of the drainage problem.*

   - None identified.

9. *Will project aggravate problem.*

   - No. The existing site condition does not exhibit signs of erosion, sedimentation, flooding, or significant destruction of aquatic habitat or organisms. The improved condition will use flow control to the Level 2 standard, assuming a forested existing condition. It is expected that the detained flows may experience a net decrease in peak flows and durations.

Based on reviews of the twelve elements above, there is no existing or potential drainage problem identified or that meets the definition of any of the four defined problem types in Section 1.2.2.1 of the *KCSWDM*. No signs of erosion or flooding were observed onsite.

3.5 Task 5 – Mitigation of Existing or Potential Problems

The downstream path is well defined. The open channel, creeks, and piped conveyance system appear to have adequate capacity. No signs of flooding or overtopping of stream channel or structures were observed.

Based on the review of the areas discussed in Task 4, no potential or existing drainage problems are identified as the four defined problem types in Section 1.2.2.1 of the *KCSWDM*. As such, mitigation of potential or existing problems will be provided through flow control BMPs. Flow control BMPs include providing flow control to the Level 2 standard, assuming a forested existing condition. As such, it is expected the project will not create or aggravate potential downstream problems.

Upstream Analysis

An estimated large TDA drains through the site, carried by the 24-inch CPEP offsite bypass system, running from South 150th Avenue southeasterly to the Type 2 catch basin south to the existing school building (Element C). Geometry and area of this TDA are not defined at this point.

3.6 Conclusion

This analysis is based on data and records either supplied to or obtained by AHBL, Inc. These documents are referenced within the text of the analysis. The analysis has been prepared utilizing procedures and practices within the standard accepted practices of the industry. We conclude that this analysis represents the field conditions as observed and researched by AHBL.

Section 4

Flow Control and Water Quality Facility Analysis and Design

4.0 Flow Control and Water Quality Facility Analysis and Design

4.1 Flow Control

4.1.1 Existing Site Hydrology (Part A)

The existing school has a parcel area of 11.24 acres and the project site consists of approximately 0.33 acre of impervious surface and 0.05 acre of pervious surface.

The bus turnaround west of the school buildings sheet flows to catch basins connecting to the detention pipe system south of the school. Parking areas to the north of the school sheet flow southeast and daylight to a swale that conveys water to a rain garden. This rain garden serves educational purposes, but is also used for detention and infiltration of stormwater runoff. This raingarden also collects water from the asphalt areas south of the school after they pass through an existing 36-inch detention pipe used for flow control.

4.1.2 Developed Site Hydrology (Part B)

The developed site will demolish existing vegetated areas, add a two-classroom modular addition, repave sidewalk, and upgrade the play area. The total new and replaced impervious surface area is 0.33 acre. This area includes new and replaced pavement, new parking area, and new building addition roof area. A portion of the existing driveway and existing landscape adjacent to the new parking area will drain to the flow control facility. This is to compensate for the roof runoff generated by the new building addition and repaving areas because they have very limited opportunity for flow control. New detention facilities are being added to contain the new/replaced impervious surfaces per the requirements in the *KCSWDM*. This facility will be added underneath the parking lot improvements in the north portion of the site. The storm systems then connect to the existing storm system in the northeast portions of the site. Calculations are provided in Section 5.0 (to be included). See Exhibit 4-3 for the developed basin map.

4.1.3 Performance Standards (Part C)

Area-Specific Flow Control Facility Standard

The project location is within an Incorporated Area per the King County Flow Control Application Map. Per the City of Tukwila, the drainage basin (Gilliam Creek) is to follow Level 2 flow control standards, Conservation to Forested.

Flow Control BMP Requirements

Flow Control BMPs are required per CR 9. The project site totals 0.52 acre. The proposed site includes 0.33 acre of impervious area, including new, replaced, and maintenance. The project falls under the Small Lot Low Impervious BMP Requirements.

Below is a summary of the Flow Control BMPs (per Section 1.2.9.2.1 of the *KCSWDM*) that the project reviewed for use:

1. **BMP Option 1:**

    a. **Full dispersion**: The project area was evaluated for full dispersion of target impervious surfaces. It was determined that full dispersion is infeasible because of site constraints and soils with little to no potential for infiltration.

2. **BMP Option 2:**

   a. **Full infiltration of roof runoff**: Soils provide little to no potential for infiltration. Therefore, full infiltration of roof runoff is infeasible.

3. **BMP Option 3:**

   a. **Full Infiltration**: Soils provide little to no potential for infiltration. Therefore, full infiltration is infeasible.

   b. **Limited Infiltration**: Soils provide little to no potential for infiltration. Therefore, limited infiltration is infeasible.

   c. **Bioretention**: The project site was evaluated for bioretention for target impervious surfaces. Raised bioretention planters will be implemented to infiltrate roof runoff generated within the new modular classrooms. Bioretention will also be used in the west portion of the site for treatment of the expanded bus loop. Amended soil mix will be used.

   d. **Permeable Pavement:** The project site was evaluated for permeable pavement. It was found that permeable pavement is infeasible due to poor soil conditions.

4. **BMP Option 4:**

   a. **Basic Dispersion**: The project site was evaluated for basic dispersion. Basic dispersion is infeasible due to the lack of native vegetated area.

5. **BMP Option 5:**

   a. **Reduced Impervious Surface Credit:** The project site was evaluated for applying the reduced impervious surface credit. It was found that the reduced impervious surface credit is infeasible because there is no area to reduce.

   b. **Native Growth Retention Credit:** The project site was evaluated for applying the native growth retention credit. It was found that the native growth retention credit is infeasible because there is not enough area to receive credit.

Conveyance System Capacity Standards

The updated storm system will be sized to convey the fully developed, 25-year storm event, as stipulated by the *KCSWDM*. The conveyance system is further described in Section 2.2.4.

4.1.4 Flow Control System (Part D)

The proposed project will provide flow control through a bioretention system or a compost amended filter strip followed by an underground stormwater chamber.

The total area for modeling consists of approximately 0.44 acre, of which 0.19 acre is new or replaced impervious surface, 0.05 acre is new vegetated area, 0.14 acre is new impervious area considered bypass, and 0.06 acre is flow through area. Runoff generated by the new parking area will be collected and controlled by the new detention facility, while runoff generated by the building addition, play area, and repaving area will be considered bypass.

The first new detention system will be located under the new parking area in the north portion of the site. Contributing areas to the first system will consist of the new parking and flow through area. Runoff will sheet flow to the compost amended filter strip, and then infiltrate to the flow control facility.

The flow control facility will be sized for approximately 0.19 acre of new impervious area and approximately 0.06 acre of flow through area (totaling 0.25 acre). Runoff generated by the new building addition will be collected by above grade bioretention planters and then discharge to the existing storm system. Runoff generated by play area and repaved surface will flow to the existing storm system directly. The MGSFlood software was used to model the site (see Exhibit 4-1).

Predeveloped Condition	0.39 ac Pervious	0.16 ac Impervious	Includes .03 ac of flow through area
Developed Condition	0.05 ac Pervious	0.33 ac Impervious	Includes 0.19 ac of parking and new and replaced asphalt, .07 ac of new modular building and .01 ac of play area.
Area Required for Flow Control	0.05 ac Pervious	0.33 ac Impervious	Runoff generated by new roof, and play area will be treated as bypass.
Area Contributing to Flow Control	0.05 ac Pervious	0.33 ac Impervious	New parking and flow through area.
	0.03 ac Pervious	0.03 ac Impervious	Area outside of project limits.
	-	0.14 ac Impervious	Bypass Area
Total	**0.05 ac Pervious**	**0.33 ac Impervious**	

Flow Control BMPs

See Exhibit 4-1 for MGSFlood Detention Sizing Calculations.

Section 5

Conveyance System Analysis and Design

5.0 Conveyance System Analysis and Design

(To be included in final submittal.)

Section 6

Special Reports and Studies

6.0 Special Reports and Studies

6.1 Geotechnical Report

Shannon & Wilson, Inc. performed a field investigation on August 27, 2018. Refer to Exhibit 6-1 for the report.

6.2 Gilliam Creek Basin Stormwater Management Plan

Herrera Environmental Consultants, Inc. prepared this document for City of Tukwila on March 9, 2001. Refer to Exhibit 6-2 for the report.

Section 7

Other Permits

7.0 Other Permits

Other than normal building permits and a right-of-way use permit, no special permits are necessary.

Section 8

CSWPPP Analysis and Design

8.0 CSWPPP Analysis and Design

The proposed improvements will comply with guidelines set forth in the *KCSWDM* and the *KCSPPM*. The plan will include erosion/sedimentation control features designed to prevent sediment-laden runoff from leaving the site or from adversely affecting critical water resources during construction. A draft stormwater pollution prevention and spill plan has been developed.

8.1 ESC Plan Analysis and Design (Part A)

The erosion potential of the site is influenced by four major factors: soil characteristics, vegetative cover, topography, and climate. Erosion/sedimentation control (ESC) is achieved by a combination of structural measures, cover measures, and construction practices that are tailored to fit the specific site. See Exhibit 8-1 for ESC and SWPPS Measures.

The following measures will be used to control sedimentation/erosion processes:

- Clearing Limits: All areas to remain undisturbed during the construction of the project will be delineated prior to any site clearing or grading.

- Cover Measures: Disturbed areas will be covered, as required in Section D.2.1.2 of the *KCSWDM*.

- Construction Entrances: A stabilized construction entrance consisting of existing asphalt of the parking lot will be used by construction traffic.

- Perimeter Protection: Filter fabric fencing will be provided along the eastern and southern perimeters to prevent sediment-laden runoff migration from the site.

- Storm Drain Inlet Protection: Filter fabric protection will be provided on all new catch basins downstream of construction activities.

- Surface Water Control: Interceptor ditches and straw wattles will be used to direct runoff from construction area to a sediment trap and/or existing stormwater pond. Temporary sedimentation trap and/or existing stormwater pond will be used to contain sediment-laden water and to control and monitor releases from site. All stormwater will be tested for NTU levels above background NTU to determine treatment requirements prior to discharge from the site.

- Dust Control: Dust control measures will be implemented when exposed soils are dry to the point that wind transport is possible and roadways, drainage ways, or surface waters are likely to be impacted.

8.1.1 ESC Maintenance

All ESC measures shall be maintained and reviewed on a regular basis, as prescribed in the maintenance requirements of each BMP proposed. See Exhibit 8-2 for ESC Maintenance Report and Exhibit 8-3 for Inspection Reports.

8.1.2 ESC Supervisor

The applicant will designate an ESC supervisor who shall be responsible for maintenance and review of ESC, and for compliance with all permit conditions relating to ESC. The ESC supervisor must be available for rapid response to ESC problems.

The ESC supervisor will review the site at least once a month during the dry season, weekly during the wet season, and within 24 hours of significant storms. The City of Tukwila may require that a written record of these reviews be kept onsite, with copies submitted to the City within 48 hours (also see Section 8.2.3 below). The City may also require that the applicant designate an ESC supervisor with demonstrated expertise in ESC to perform these reviews and to be responsible for ESC due to the sensitive areas on or within the project site. The qualifications of such a person shall include at least several years of construction supervision or inspection.

8.1.3 Documentation

If City of Tukwila requires that a written record be maintained, a standard ESC Maintenance Report may be used. A copy of all required maintenance reports shall be kept onsite throughout the duration of construction. Detailed maintenance requirements for each ESC measure are provided in Section 8.2.

8.1.4 Review Timing

During the wet season, weekly reviews shall be carried out every 6 to 8 calendar days. During the dry season, monthly reviews shall be carried out within 3 days of the calendar day for the last inspection (e.g., if an inspection occurred on June 6, then the next inspection must occur between July 3 and July 9). Reviews shall also take place within 24 hours of significant storms. In general, a significant storm is one with more than 0.5 inch of rain in 24 hours or less.

8.2 Stormwater Pollution Prevention and Spill (SWPPS) Plan Design (Part B)

The below draft SWPPS Plan design is awaiting input from the contractor and the owner for specific items. An updated plan will be provided with the building permit submittal.

The Stormwater Pollution Prevention and Spill (SWPPS) Plan includes three elements: a site plan, a pollution prevention report, and a spill prevention and cleanup report. This report includes identifying the expected sources of potential pollution and spills that may occur during construction, and works to develop a plan to prevent pollution and spills. It also develops a plan to mitigate spills that may occur. The SWPPS Plan will be kept onsite at all times during construction. The general contractor will be responsible to ensure that subcontractors are aware of the SWPPS Plan and a form or record will be provided stating that all subcontractors have read and agree to the SWPPS Plan. An employee training worksheet is provided for the contractor's use (see Exhibit 8-3).

A SWPPS Site Plan will be submitted. The SWPPS Site Plan, Pollution Prevention Report, and Spill Prevention and Cleanup Report have been developed and BMPs have been selected based on Section 2.3.1.4 of the *KCSWDM* and the *KCSPPM*. *(The below plan will be updated with input from the owner and contractor.)*

8.2.1 Pollution and Spill Prevention Source Controls and BMPs

The sources of pollution and spills have been identified below, and the BMPs to be used for each source for prevention of both pollution and spills have been listed below:

Liquids that will be handled or stored onsite are still being assessed by the owner.

Tight-fitting lids shall be placed on all containers containing liquids. Containers shall be covered with plastic sheeting during rain events. Drip pans or absorbent materials shall be placed beneath all mounted container taps and at all potential drip and spill locations during filling and unloading of containers. Containers shall be stored such that, if a container leaks or spills, the

contents will not be discharged, flow, or be washed into the storm drainage system, surface water, or groundwater. Appropriate spill cleanup materials shall be stored and maintained near the container storage area. Storage area shall be swept and cleaned as needed. Area shall not be hosed down such that water drains to the storm drainage system or neighboring areas. Containers shall be checked daily for leaks and spills and replaced as necessary. All spilled liquids will be collected and disposed of properly. Spill control devices shall be routinely inspected on a weekly basis.

Dry pesticides and fertilizers if stored onsite shall be covered with plastic sheeting or stored in a sealed container. Materials shall be stored on pallets or another raised method to prevent contact with stormwater runoff. Alternatively, the materials shall be contained in a manner such that if the container leaks or spills, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters, or groundwater. Maintenance requirements are the same as liquid materials described above.

Chemicals that will be handled or stored onsite are still being assessed by the owner.

BMPs and Maintenance requirements are the same as liquids unless otherwise listed.

Soil, sand, and other erodible materials shall be stored onsite as shown on TESC detail plans (to be provided).

Fueling shall not occur onsite. If fueling does occur onsite, the contractor shall develop a containment plan for spills and provide lighting and signage if fueling occurs at night in conformance with the *KCSPPM*.

Maintenance and repair of vehicles shall not occur onsite. If maintenance or repair of vehicles does occur onsite, the contractor shall develop a spill prevention plan in conformance with the *KCSPPM*.

Truck wheel washing is not expected at a large scale due to small area of disturbance for the project. All other **vehicle washing** shall occur in a controlled manner, such that runoff is collected and disposed of in a legal manner.

Rinsing of hand tools shall occur as located on the TESC plans (to be provided with the building permit submittal). Water for washing shall be collected and disposed of in a legal manner.

Contaminated soils are not expected. If encountered, contaminated soils will be covered with plastic to prevent stormwater from carrying pollutants away to surface or ground waters. Appropriate spill cleanup materials, such as brooms, dustpans, vacuum sweepers, etc., shall be stored and maintained near the storage area. Storage area shall be swept and cleaned as needed. Area shall not be hosed down such that water drains to the storm drainage system, groundwater, surface water, or neighboring areas.

During **concrete and asphalt construction**, the contractor shall provide the following BMPs or equivalent measures, methods or practices as required:

1. Drip pans, ground cloths, heavy cardboard or plywood wherever concrete, asphalt and asphalt emulsion chunks and drips are likely to fall unintentionally, such as beneath extraction points from mixing equipment.

2. Storm drain inlet protection is being provided as shown on TESC plans (to be provided). Storm drains shall be covered to prevent concrete and asphalt from entering the storm system.

3. Concrete, concrete slurry and rinse water shall be contained and collected and shall not be washed or allowed to discharge into storm drain, ditch, or neighboring parcels. All collected runoff shall be properly disposed of.

4. Contractor shall designate an area where application and mixing equipment cleaning will be conducted. Rinse water and slurry shall be collected, contained, and disposed of in a legal manner.

5. Routine maintenance: the pouring area shall be swept at the end of each day or more frequently if needed. Loose aggregate chunks and dust shall be collected. Areas shall not be hosed down.

The contractor may provide the following optional BMPs if the above do not provide adequate source controls:

6. Cover portable mixing equipment with an awning or plastic sheeting to prevent contact with rainfall.

7. Provide catch basin inserts configured for pollutant removal.

pH elevated water shall not be discharged from the site. Contractor shall monitor stormwater for pH prior to discharging from the site. Contractor shall implement a pH treatment plan if pH is not within the natural range.

8.2.2 Responsible Personnel and Contact Information

__[name]__ with __[company]__ shall be responsible for pollution and spill prevention and cleanup and can be contacted at __[phone]__ or __[email]__

Contractor shall fill out the attached Pollution Prevention Team Worksheet (see Exhibit 8-3).

8.2.3 Pollution and Spill Prevention Worksheets

Pollution prevention, BMP implementation reports, material inventory worksheets, pollutant source identification worksheet, and spill/leak report may be found attached as Exhibit 8-3.

8.2.4 Disposal Methods

Contractor shall dispose of contaminated soils and water in a legal manner.

Section 9

Bond Quantities, Facility Summaries, and Declaration of Covenant

9.0 Bond Quantities, Facility Summaries, and Declaration of Covenant

Financial guarantees are not required for publically funded projects or public organizations per Washington Administrative Code.

Section 10

Operations and Maintenance Plan

10.0 Operations and Maintenance Plan

The drainage facilities detailed in this report will be privately owned and maintained.

10.1 Facility Descriptions

Detention Vault

The purpose of the detention tank is to reduce the rate of stormwater runoff from developed portions of the property. Water can flow freely into the tank, but orifices in the outflow riser restrict the outflow. When the inflow exceeds the capacity of the orifices, the excess water is "stored" in the tank and released slowly after the storm abates.

In order to function properly, the tank must be kept free of excessive accumulated sediment. The outlet pipe also must be kept clean, as even a partial blockage could significantly impact the ability of a facility to store runoff. The facility should be visually inspected for sediment accumulation and blockages at least once each year and after every major storm greater than or equal to a 10-year return frequency.

Conveyance Systems

Pipes, trench drains, and swales transport stormwater runoff from developed portions of the property to the detention vault, and then to the downstream points of connection. To work properly, pipes and trench drains must be kept free of silt and other debris. If trench drains or pipes become blocked, surface flooding will occur.

Catch Basins and Area Drains

Catch basins collect surface drainage and direct it into storm conveyance pipes. They help prevent downstream drainage problems by trapping sediment and other debris that would otherwise flow downstream with the runoff. It is important to keep catch basins clean so that accumulated silt is not flushed out during a significant storm. In addition, if the outflow pipe becomes blocked with debris, surface flooding will occur. All catch basins should be inspected at least once each year and after major storms.

Area drains convey runoff directly into conveyance pipes. To prevent surface flooding, their surface grates must be kept free of litter and debris. If dirt or other sediment gets into the pipes and they become blocked, the pipes will need to be cleaned, either manually or using a Vactor truck.

10.2 Maintenance Tasks

See Exhibit 10-1 for a Storm Facility Maintenance Checklist.

10.3 Maintenance Requirements

See Exhibit 10-2 for a copy of the Maintenance Requirements for Flow Control, Conveyance, and Water Quality Facilities.

Section 11

Conclusion

11.0 Conclusion

It was determined using these criteria that:

- Detention facilities have been designed to meet the required Level 2 Flow Control standard.
- Pipe networks will be adequately designed to convey the 25-year storm event and to contain the 100-year storm event.

This analysis is based on data and records either supplied to or obtained by AHBL. These documents are referenced within the text of the analysis. The analysis has been prepared utilizing procedures and practices within the standard accepted practices of the industry. We conclude that this project, as schematically represented, will not create any new problems within the downstream drainage system. This project will not noticeably aggravate any existing downstream problems due to either water quality or quantity.

AHBL, Inc.

Casey Jeszeck, EIT
Project Engineer

CJ/lsk

January 2019

Q:\2018\2180149\WORDPROC\Reports\20181024 (TIR) 2180149.10.docx

Section 1.0 Attachments

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER

Project Owner: Tukwila School District
Phone: 206-901-8000
Address: 4640 S 144th Street
Tukwila, WA 98168
Project Engineer: Casey Jeszeck
Company: AHBL, Inc.
Phone: 206-267-2425

Part 2 PROJECT LOCATION AND DESCRIPTION

Project Name: Tukwila Elementary School
DPER Permit #: _____
Location Township: 23 NE
Range: 04
Section: 23
Site Address: 5939 S 149th St
Tukwila, WA 98168

Part 3 TYPE OF PERMIT APPLICATION

- ☐ Landuse (e.g.,Subdivision / Short Subd. / UPD)
- ☒ Building (e.g.,M/F / Commercial / SFR)
- ☐ Clearing and Grading
- ☐ Right-of-Way Use
- ☐ Other _____

Part 4 OTHER REVIEWS AND PERMITS

- ☐ DFW HPA
- ☐ COE 404
- ☐ DOE Dam Safety
- ☐ FEMA Floodplain
- ☐ COE Wetlands
- ☐ Other _____
- ☐ Shoreline Management
- ☐ Structural Rockery/Vault/_____
- ☐ ESA Section 7

Part 5 PLAN AND REPORT INFORMATION

Technical Information Report

Type of Drainage Review (check one):
- ☒ Full
- ☐ Targeted
- ☐ Simplified
- ☐ Large Project
- ☐ Directed

Date (include revision dates): _____
Date of Final: _____

Site Improvement Plan (Engr. Plans)

Plan Type (check one):
- ☒ Full
- ☐ Modified
- ☐ Simplified

Date (include revision dates): _____
Date of Final: _____

Part 6 SWDM ADJUSTMENT APPROVALS

Type (circle one): (Standard) / Experimental / Blanket

Description: (include conditions in TIR Section 2)

_____

_____

_____

Approved Adjustment No. _____ Date of Approval: _____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 7 MONITORING REQUIREMENTS

Monitoring Required: Yes / No

Start Date: _____

Completion Date: _____

Describe: _____

_____

_____

Re: KCSWDM Adjustment No. _____

Part 8 SITE COMMUNITY AND DRAINAGE BASIN

Community Plan : _____

Special District Overlays: _____

Drainage Basin: _____

Stormwater Requirements: _____

Part 9 ONSITE AND ADJACENT SENSITIVE AREAS

- ❑ River/Stream _____
- ❑ Lake _____
- ❑ Wetlands _____
- ❑ Closed Depression _____
- ❑ Floodplain _____
- ❑ Other _____

_____

- ❑ Steep Slope _____
- ❑ Erosion Hazard _____
- ❑ Landslide Hazard _____
- ❑ Coal Mine Hazard _____
- ❑ Seismic Hazard _____
- ❑ Habitat Protection _____
- ❑ _____

Part 10 SOILS

Soil Type	Slopes	Erosion Potential
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

- ❑ High Groundwater Table (within 5 feet)
- ❑ Other _____
- ❑ Sole Source Aquifer
- ❑ Seeps/Springs

❑ Additional Sheets Attached

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 11 DRAINAGE DESIGN LIMITATIONS	
REFERENCE	LIMITATION / SITE CONSTRAINT
❑ Core 2 – Offsite Analysis _____	_____
❑ Sensitive/Critical Areas _____	_____
❑ SEPA _____	_____
❑ LID Infeasibility _____	_____
❑ Other _____	_____
❑ _____	_____
❑ Additional Sheets Attached	

Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)	
Threshold Discharge Area: (name or description)	Gilliam Watershed
Core Requirements (all 8 apply):	
Discharge at Natural Location	Number of Natural Discharge Locations:
Offsite Analysis	Level: 1 / 2 / 3 dated:_____
Flow Control (include facility summary sheet)	Level: 1 / 2 / 3 or Exemption Number _____ Flow Control BMPs _____
Conveyance System	Spill containment located at: _____
Erosion and Sediment Control / Construction Stormwater Pollution Prevention	CSWPP/CESCL/ESC Site Supervisor: _____ Contact Phone: _____ After Hours Phone: _____
Maintenance and Operation	Responsibility (circle one): Private / Public If Private, Maintenance Log Required: Yes / No
Financial Guarantees and Liability	Provided: Yes / No
Water Quality (include facility summary sheet)	Type (circle one): Basic / Sens. Lake / Enhanced Basic / Bog or Exemption No. _____ Landscape Management Plan: Yes / No
Special Requirements (as applicable):	
Area Specific Drainage Requirements	Type: CDA / SDO / MDP / BP / LMP / Shared Fac. / None Name: _____
Floodplain/Floodway Delineation	Type (circle one): Major / Minor / Exemption / None 100-year Base Flood Elevation (or range): _____ Datum:
Flood Protection Facilities	Describe:

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)	
Source Control (commercial / industrial land use)	Describe land use: Describe any structural controls:
Oil Control	High-use Site: Yes / No Treatment BMP: _____ Maintenance Agreement: Yes / No with whom? _____
Other Drainage Structures	
Describe:	

Part 13 EROSION AND SEDIMENT CONTROL REQUIREMENTS

MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION		MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION
❑ Clearing Limits		❑ Stabilize exposed surfaces
❑ Cover Measures		❑ Remove and restore Temporary ESC Facilities
❑ Perimeter Protection		❑ Clean and remove all silt and debris, ensure operation of Permanent Facilities, restore operation of Flow Control BMP Facilities as necessary
❑ Traffic Area Stabilization		❑ Flag limits of SAO and open space preservation areas
❑ Sediment Retention		❑ Other _____
❑ Surface Water Collection		
❑ Dewatering Control		
❑ Dust Control		
❑ Flow Control		
❑ Protection of Flow Control BMP Facilities (existing and proposed)		
❑ Maintain BMPs / Manage Project		

Part 14 STORMWATER FACILITY DESCRIPTIONS (Note: Include Facility Summary and Sketch)

Flow Control	Type/Description		Water Quality	Type/Description
❑ Detention	_____		❑ Vegetated Flowpath	_____
❑ Infiltration	_____		❑ Wetpool	_____
❑ Regional Facility	_____		❑ Filtration	_____
❑ Shared Facility	_____		❑ Oil Control	_____
❑ Flow Control BMPs	_____		❑ Spill Control	_____
❑ Other	_____		❑ Flow Control BMPs	_____
			❑ Other	_____

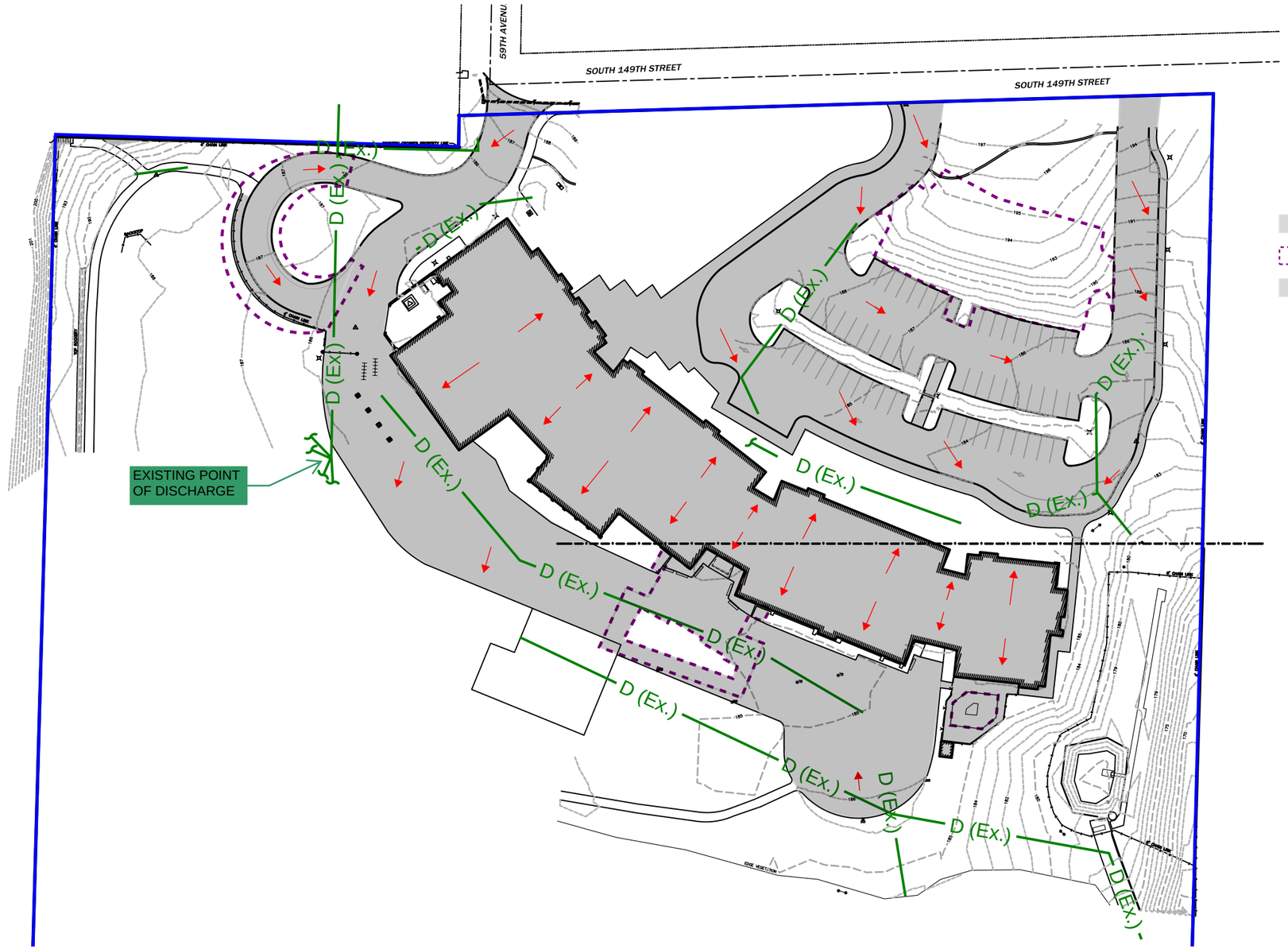
TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 15 EASEMENTS/TRACTS		Part 16 STRUCTURAL ANALYSIS
❑ Drainage Easement ❑ Covenant ❑ Native Growth Protection Covenant ❑ Tract ❑ Other _____		❑ Cast in Place Vault ❑ Retaining Wall ❑ Rockery > 4' High ❑ Structural on Steep Slope ❑ Other _____

Part 17 SIGNATURE OF PROFESSIONAL ENGINEER
I, or a civil engineer under my supervision, have visited the site. Actual site conditions as observed were incorporated into this worksheet and the attached Technical Information Report. To the best of my knowledge the information provided here is accurate. _____ *Signed/Date*

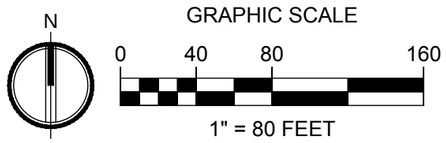
Exhibit 1-2 Vicinity Map

Tukwila ES Addition



Legend

Description	Quantity	Unit
Non-Target Impervious Area	2.96	ac
Project Site Area	0.52	ac
Target Impervious Area	0.13	ac



AHBL
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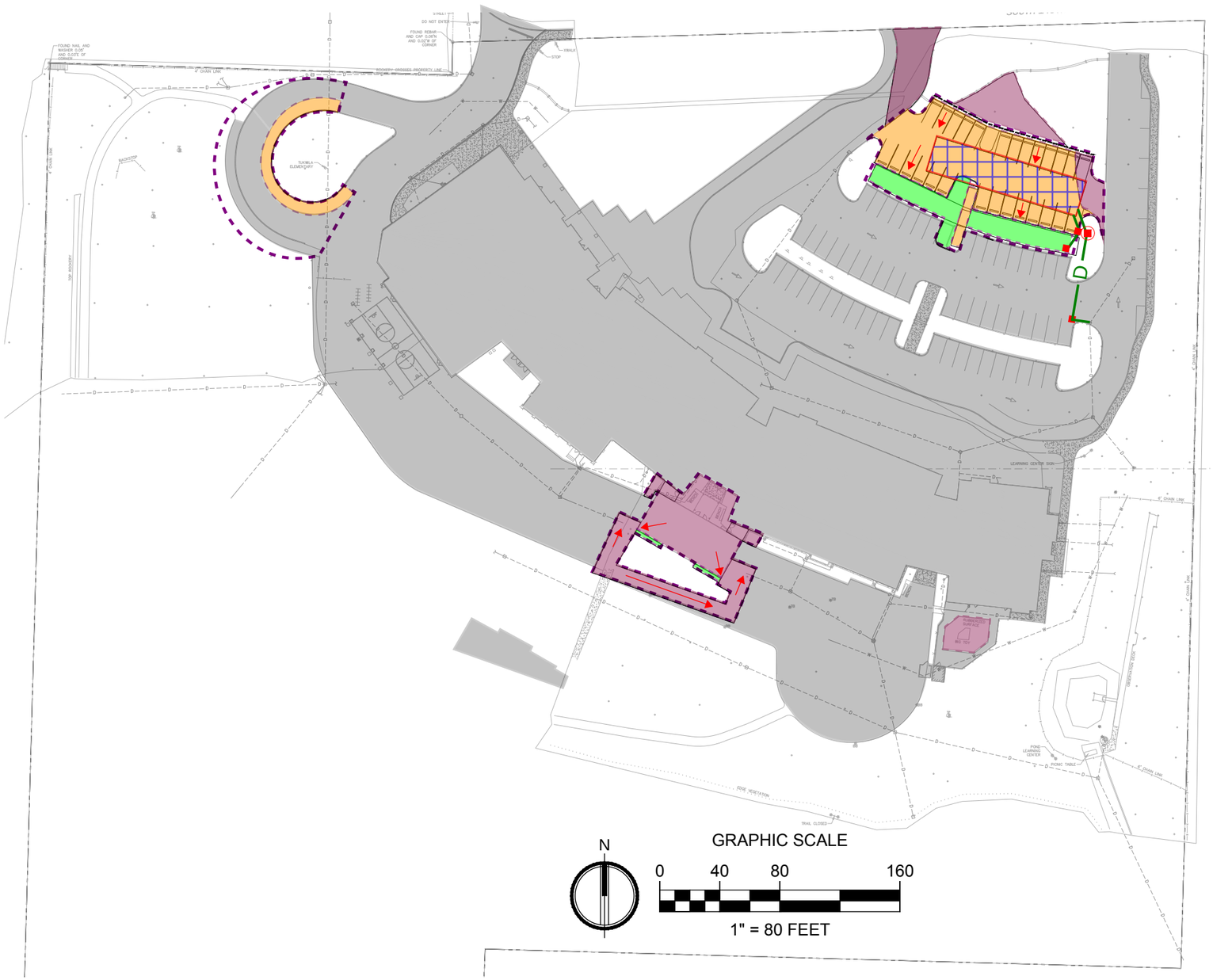
Suite 1620
Seattle, WA 98101
206.267.2425 TEL
206.267.2429 FAX

TUKWILA ELEMENTARY SCHOOL ADDITION

EXISTING CONDITIONS MAP

EXHIBIT 1-3



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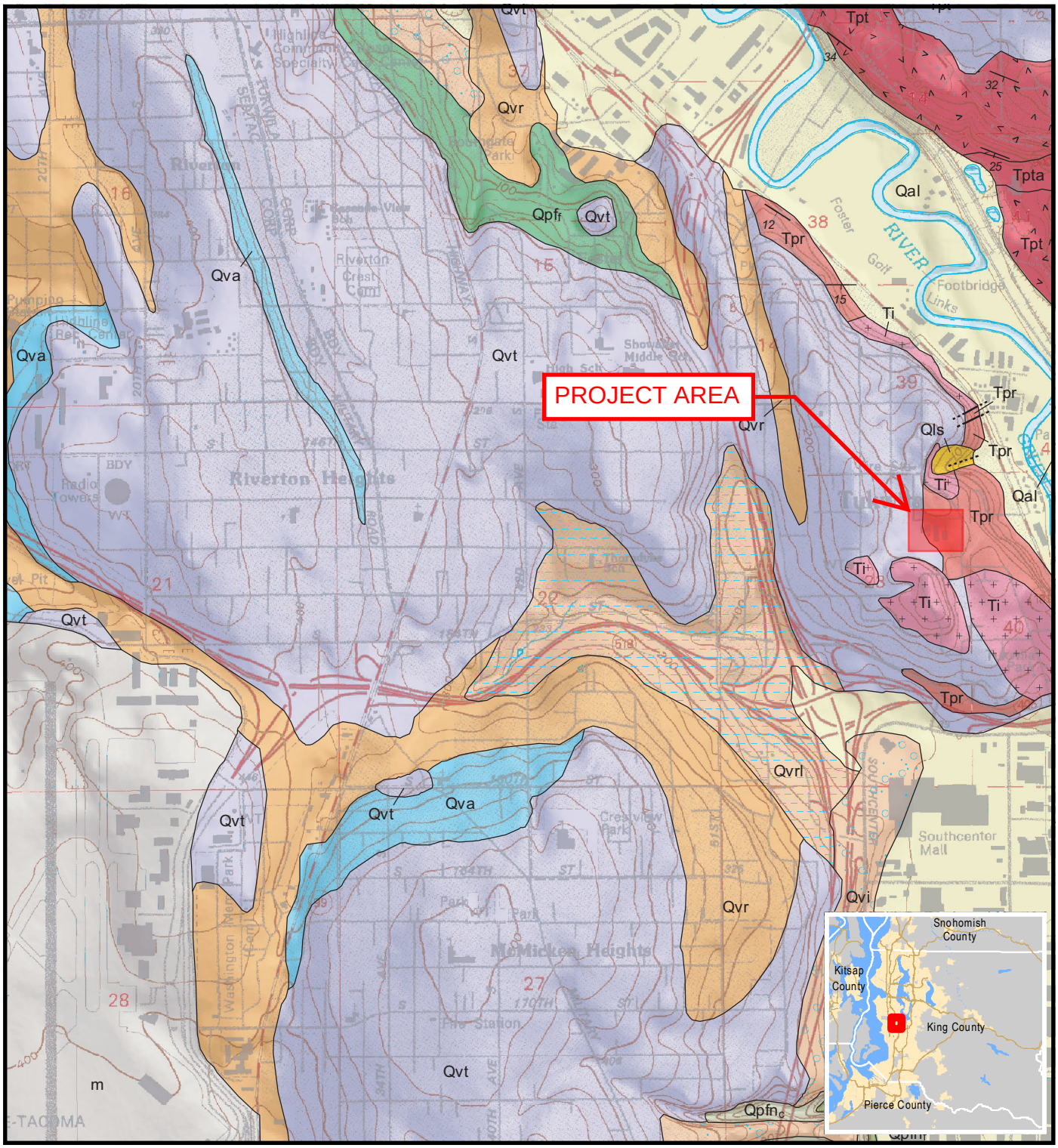
TUKWILA ELEMENTARY SCHOOL

DEVELOPED CONDITIONS MAP

EXHIBIT 1-4



DATA SOURCES / REFERENCES:
KING CO: STREETS, PARCELS 12/16
USGS: SIM-2855

Qvt: Till
Qvi: Ice-contact deposits
Qvr: Recessional lacustrine deposits
Qal: Alluvium (Holocene)

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TUKWILA ELEMENTARY SCHOOL MODULAR ADDITIONS

SOILS SURVEY MAP

EXHIBIT 1-5

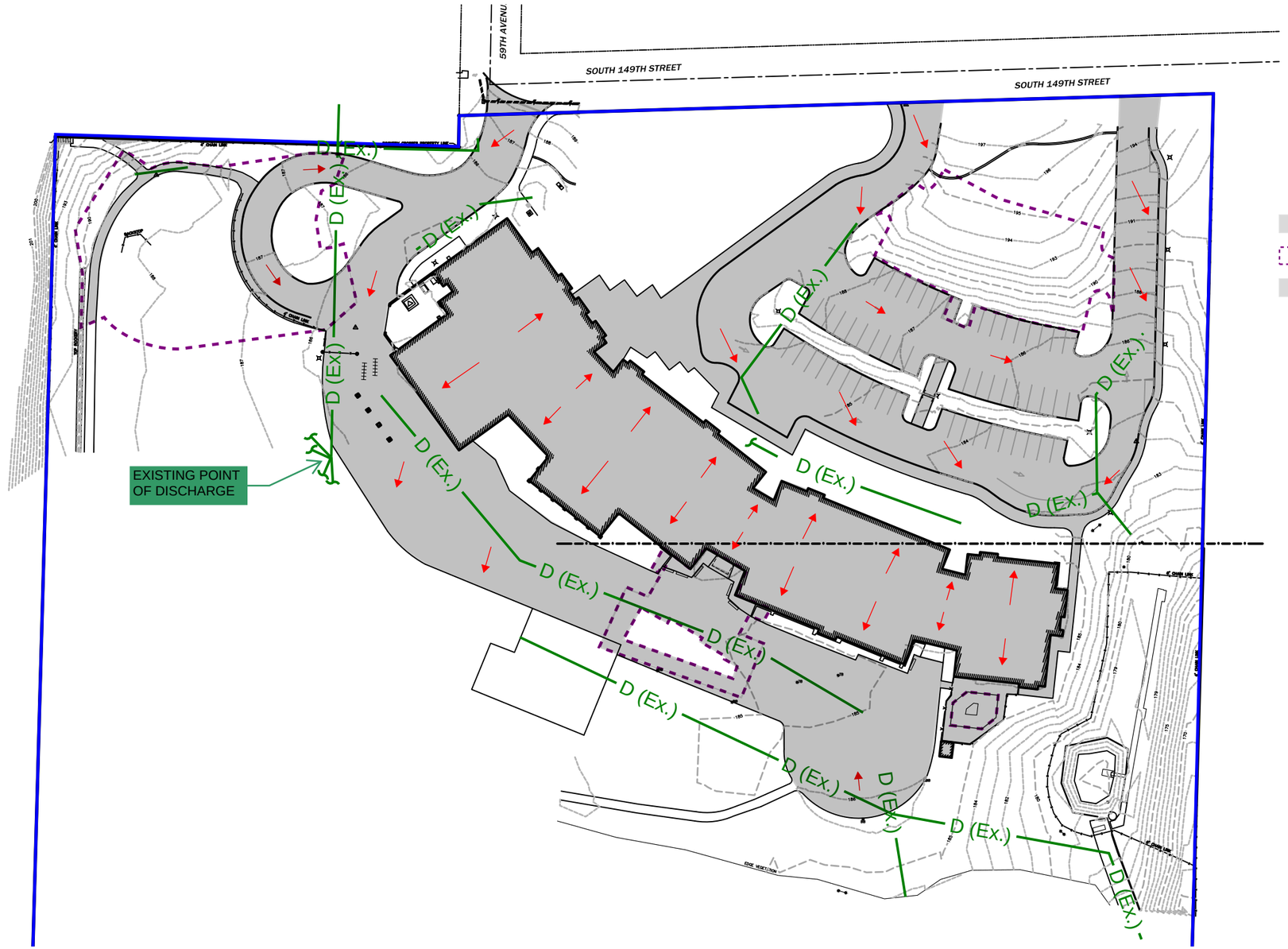
Section 2.0 Attachments

(No Attachments)

Section 3.0 Attachments

Exhibit 3-1 Vicinity Map

Tukwila ES Addition



Legend

Description	Quantity	Unit
Non-Target Impervious Area	2.87	ac
Project Site Area	0.82	ac
Target Impervious Area	0.26	ac

GRAPHIC SCALE

0 40 80 160

1" = 80 FEET

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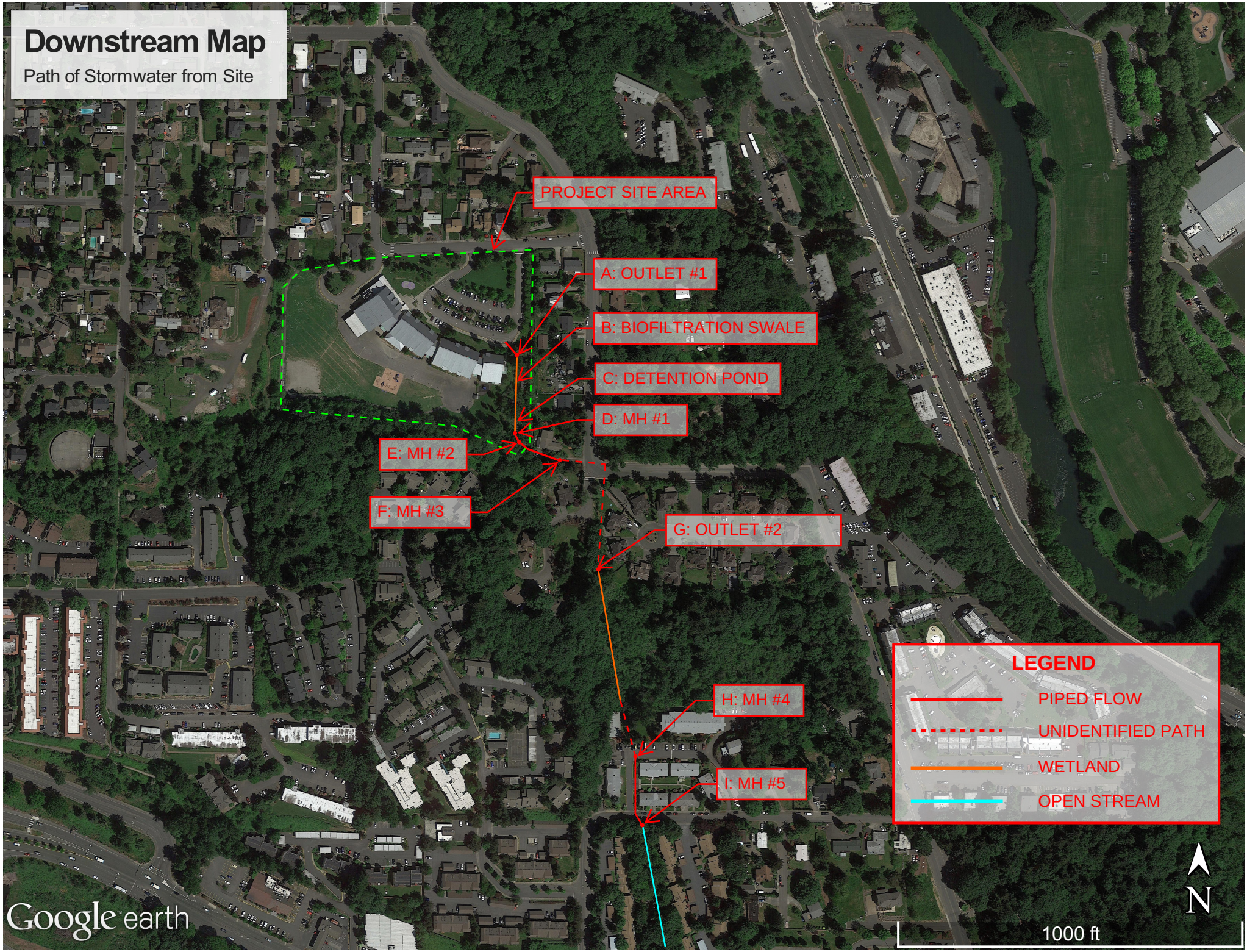
TUKWILA ELEMENTARY SCHOOL ADDITION

EXISTING CONDITIONS MAP

3-2


Downstream Map
Path of Stormwater from Site
PROJECT SITE AREA
A: OUTLET #1
B: BIOFILTRATION SWALE
C: DETENTION POND
D: MH #1
E: MH #2
F: MH #3
G: OUTLET #2
H: MH #4
I: MH #5
LEGEND
PIPED FLOW
UNIDENTIFIED PATH
WETLAND
OPEN STREAM
N
1000 ft
Google earth

Tukwila Elementary School
Downstream Analysis

DATE: **8/22/2018**
BY: **Casey Jeszeck**

DRAINAGE ELEMENT (SEE A-4)					
#	**DESCRIPTION**	**IN**	**OUT**	**PHOTOS**	**OBSERVATIONS OF FIELD INSPECTOR**
A	OUTLET #1		12"		
B	BIOFILTRATION SWALE				WETLAND IN GOOD CONDITION
C	DETENTION POND				POND IN GOOD CONDITION
D	MH #1	12"	12"		MANHOLE STUCTURE WITH OVERFLOW WEIR ON TOP OF INLET PIPE; OUTLET PIPE CONSTRUCTED WITH VERTICAL RISER, NOTCH WEIR, AND SHEAR VALVE.
E	MH #2	12" 18"	24"		
F	MH #3	24" 12"	24"		
G	OUTLET #2		24"		CONCRETE PIPE DAYLIGHT AND DISCHARGE TO A NARROW STREAM.
H	MH #4	24"	12" 12"		
I	MH #5	24"	24"		

A

B/C

D-1

D-2

E-1

E-2

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TUKWILA ELEMENTARY SCHOOL ADDITION

DOWNSTREAM ANALYSIS PHOTOS

DRAWN BY: C. JESZECK | DATE: 8/23/2018 | JOB NO.: 21801149.10

CSK 01

F-1

F-2

G

H

I

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TUKWILA ELEMENTARY SCHOOL ADDITION

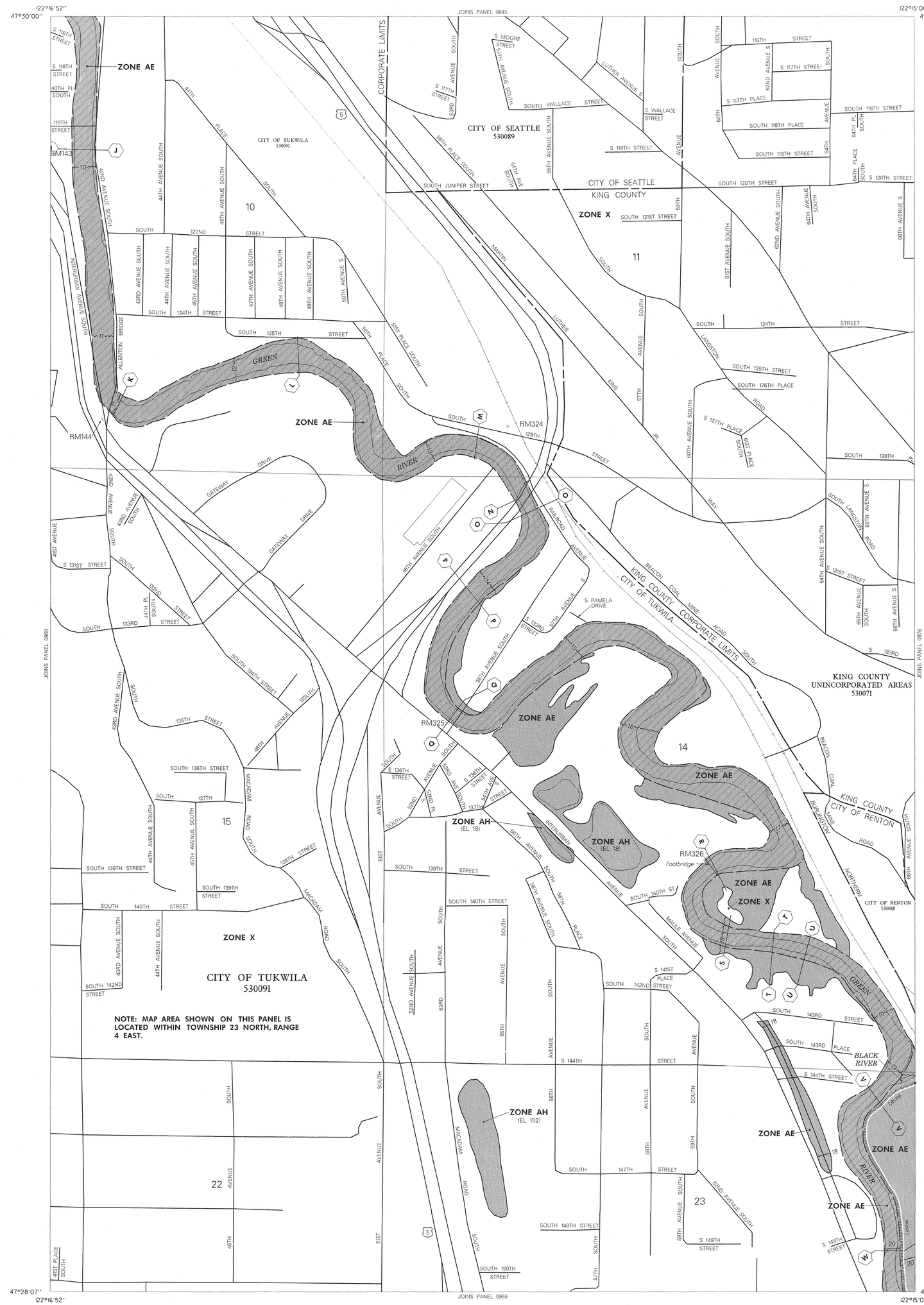
DOWNSTREAM ANALYSIS PHOTOS

DRAWN BY: C. JESZECK	DATE: 8/23/2018	JOB NO.: 21801149.10

CSK 02

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
RM143	18.76	A chiseled cross on southeast end of concrete sidewalk to footbridge at top of left bank.
RM144	17.35	A chiseled square at left downstream end of concrete bridge pier, Riverton Highway bridge.
RM324	24.46	A 60 penny spike on 40 inch maple on right bank 100 feet downstream from Old Highway overpass over railroad, 25 feet east of powerline river crossing.
RM325	23.39	A chiseled cross on concrete of foundation of archway at entrance to Foster Golf Course located on northwest corner of foundation and left bank of Green River.
RM326	23.41	Chiseled square on southeast corner of west anchor base at north end of footbridge across Green River at Foster Golf Course. Established by U.S. Army Corps of Engineers.



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** — No base flood elevations determined.
- **ZONE AE** — Base flood elevations determined.
- **ZONE AH** — Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE AO** — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined; for areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** — To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
- **ZONE V** — Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** — Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** — Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** — Areas determined to be outside 500-year floodplain.
- **ZONE D** — Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

- Flood Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
- 513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.
- D — D — Cross Section Line
- (EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.
- RM7 — Elevation Reference Mark
- M2 — River Mile
- 97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101-591).

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
SEPTEMBER 29,1989

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:
Revised May 16, 1995 to update map format.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET
500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 957 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

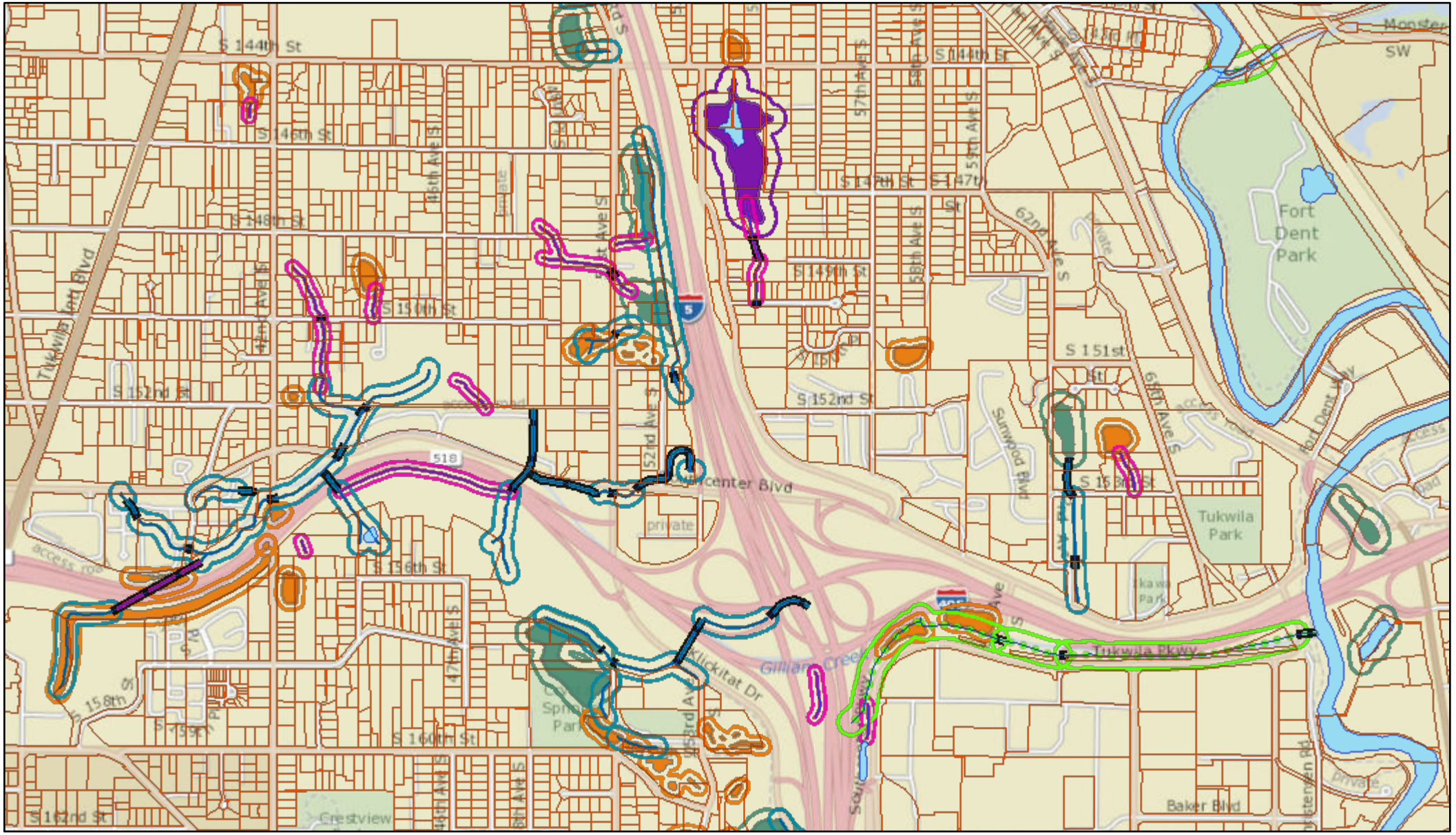
CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY: UNINCORPORATED AREAS	530071	0957	F
RENTON, CITY OF	530088	0957	F
SEATTLE, CITY OF	530089	0957	F
TUKWILA, CITY OF	530091	0957	F

MAP NUMBER
53033C0957 F

MAP REVISED:
MAY 16, 1995

Federal Emergency Management Agency

Tukwila Sensitive Area's Map



Parcels
WaterBodies
Streams

StreamBuffers	WetlandsBuffer	Wetlands	Streams
50	100	Category II	Type 2 Stream
80	80	Category III	Type 2 Stream in Pipe
100	50	Category IV	Type 3 Stream

1:18,056

0 0.1 0.2 0.4 mi

0 0.15 0.3 0.6 km

Tukwila Technology Services, King County

EXHIBIT 3-7

City of Tukwila

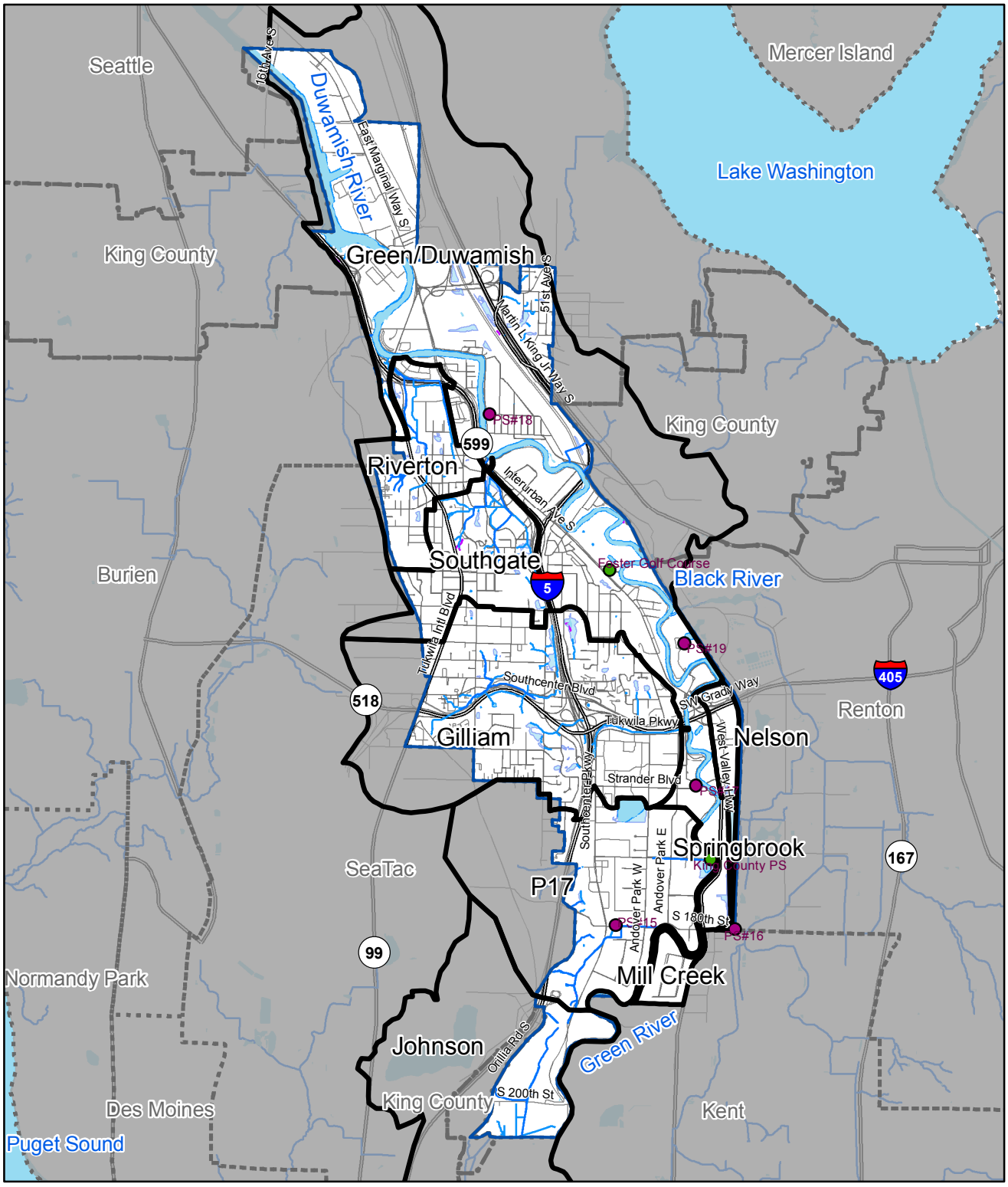
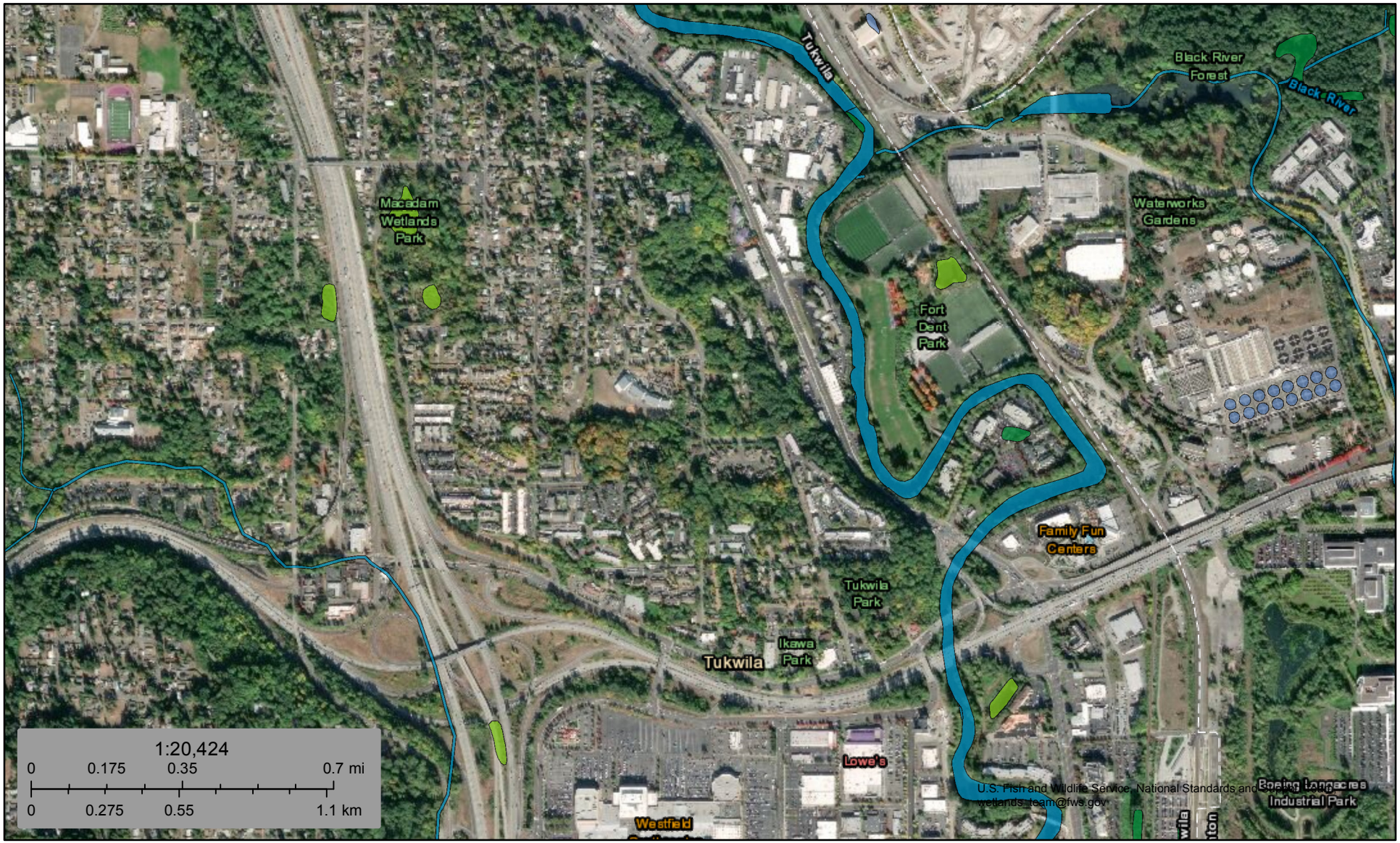


FIGURE 2
City of Tukwila Drainage Basins
City of Tukwila 2012 Surface Water Comprehensive Plan

U.S. Fish and Wildlife Service
National Wetlands Inventory

Tukwila Elementary School Wetland Map



August 20, 2018

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

1200 6th Avenue
Suite 1620
Seattle, WA 98101
206.267.2425 TEL
206.267.2429 FAX

TUKWILA ELEMENTARY SCHOOL MODULAR ADDITIONS

303(d) List of Polluted Waters Map

EXHIBIT 3-10

Section 4.0 Attachments

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.43
Program License Number: 201710010
Project Simulation Performed on: 01/07/2019 9:30 AM
Report Generation Date: 01/07/2019 9:30 AM

Input File Name: Tukwila ES MGS.fld
Project Name: Tukwila ES N-S
Analysis Title:
Comments: 2180149.10

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Time Series Selected
Climatic Region Number: 0

Full Period of Record Available used for Routing
Precipitation Station : 96004005 Puget East 40 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961040 Puget East 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** **********

Predevelopment/Post Development Tributary Area Summary

	Predeveloped	Post Developed
Total Subbasin Area (acres)	0.393	0.360
Area of Links that Include Precip/Evap (acres)	0.000	0.033
Total (acres)	0.393	0.393

----------SCENARIO: PREDEVELOPED
Number of Subbasins: 3

---------- Subbasin : Site N and Mod ----------

	-------Area (Acres) --------
Till Forest	0.190
Subbasin Total	0.190

---------- Subbasin : Flow Through ----------

	-------Area (Acres) --------
Outwash Grass	0.030
Impervious	0.030
Subbasin Total	0.060

---------- Subbasin : Bypass Area ----------

	-------Area (Acres) --------
Impervious	0.143
Subbasin Total	0.143

----------SCENARIO: POSTDEVELOPED
Number of Subbasins: 4

---------- Subbasin : Target Area N ----------

	-------Area (Acres) --------
Impervious	0.160
Subbasin Total	0.160

---------- Subbasin : Flow Through N ----------

	-------Area (Acres) --------
Outwash Grass	0.030
Impervious	0.030
Subbasin Total	0.060

---------- Subbasin : Addition (Bypass) ----------

	-------Area (Acres) --------
Impervious	0.110
Subbasin Total	0.110

---------- Subbasin : Play Area (Bypass) ----------

	-------Area (Acres) --------
Impervious	0.030
Subbasin Total	0.030

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

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

Link Name: POC
Link Type: Copy
Downstream Link: None

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

----------SCENARIO: POSTDEVELOPED
Number of Links: 4

Link Name: CAVFS N
Link Type: Compost Amended Vegetated Filter Strip (CAVFS)
Downstream Link Name: StormChamber N

Compost Thickness (ft)	: 3.500
Compost Porosity (%)	: 46.000
Compost Hydraulic Conductivity (in/hr)	: 1.500
CAVFS Length (ft)	: 130.000
CAVFS Width (ft)	: 10.000
CAVFS Slope, Z (ft/ft)	: 25.000
Gravel Spreader Width (ft)	: 2.000
Gravel Hydraulic Conductivity (in/hr)	: 2.000
Gravel Porosity (%)	: 30.000
Soil Infiltration Rate (in/hr)	: 0.000

Precipitation and Evaporation Applied to Surface of CAVFS

Link Name: StormChamber N
Link Type: Structure
Downstream Link Name: POC Inflow

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 103.00
Max Pond Elevation (ft) : 103.50
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 45.0
Pond Bottom Width (ft) : 15.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 675.
Area at Riser Crest El (sq-ft) : 675.
(acres) : 0.015
Volume at Riser Crest (cu-ft) : 2,025.
(ac-ft) : 0.046
Area at Max Elevation (sq-ft) : 675.
(acres) : 0.015
Vol at Max Elevation (cu-ft) : 2,430.
(ac-ft) : 0.056

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 18.00
Common Length (ft) : 0.010
Riser Crest Elevation : 103.00 ft

Hydraulic Structure Geometry

Number of Devices: 3

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.50
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.20
Diameter (in) : 0.50
Orientation : Vertical
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice
Control Elevation (ft) : 102.30
Diameter (in) : 0.25
Orientation : Horizontal
Elbow : Yes

Link Name: Bioretention Planter S
Link Type: Bioretention Facility
Downstream Link Name: POC Inflow

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 101.00
Storage Depth (ft) : 1.00
Bottom Length (ft) : 40.0
Bottom Width (ft) : 3.0

Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 120.
Area at Riser Crest El (sq-ft) : 120.
(acres) : 0.003
Volume at Riser Crest (cu-ft) : 203.
(ac-ft) : 0.005

Infiltration on Bottom only Selected

Soil Properties
Biosoil Thickness (ft) : 1.50
Biosoil Saturated Hydraulic Conductivity (in/hr) : 1.50
Biosoil Porosity (Percent) : 46.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 6.00
Common Length (ft) : 0.000
Riser Crest Elevation : 101.00 ft

Hydraulic Structure Geometry

Number of Devices: 0

Link Name: POC Inflow
Link Type: Copy
Downstream Link: None

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

----------SCENARIO: PREDEVELOPED
Number of Subbasins: 3
Number of Links: 1

********** Subbasin: Site N and Mod **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.049E-03
5-Year	6.599E-03
10-Year	8.891E-03
25-Year	1.127E-02
50-Year	1.439E-02
100-Year	1.559E-02
200-Year	2.427E-02

********** Subbasin: Flow Through **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	1.135E-02
5-Year	1.457E-02
10-Year	1.712E-02
25-Year	2.158E-02
50-Year	2.716E-02
100-Year	3.030E-02

200-Year	3.143E-02

********** **Subbasin: Bypass Area** **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	5.329E-02
5-Year	6.922E-02
10-Year	7.787E-02
25-Year	9.802E-02
50-Year	0.125
100-Year	0.144
200-Year	0.150

********** Link: POC ********** Link Inflow Frequency Stats

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	6.647E-02
5-Year	8.461E-02
10-Year	0.101
25-Year	0.133
50-Year	0.158
100-Year	0.177
200-Year	0.182

----------SCENARIO: POSTDEVELOPED
Number of Subbasins: 4
Number of Links: 4

********** **Subbasin: Target Area N** **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	5.963E-02
5-Year	7.745E-02
10-Year	8.713E-02
25-Year	0.110
50-Year	0.140
100-Year	0.161
200-Year	0.167

********** **Subbasin: Flow Through N** **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	1.135E-02
5-Year	1.457E-02
10-Year	1.712E-02
25-Year	2.158E-02
50-Year	2.716E-02
100-Year	3.030E-02
200-Year	3.143E-02

********** **Subbasin: Addition (Bypass)** **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.099E-02
5-Year	5.325E-02
10-Year	5.990E-02
25-Year	7.540E-02
50-Year	9.598E-02
100-Year	0.111
200-Year	0.115

********** **Subbasin: Play Area (Bypass)** **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	1.118E-02
5-Year	1.452E-02
10-Year	1.634E-02
25-Year	2.056E-02
50-Year	2.618E-02
100-Year	3.026E-02
200-Year	3.137E-02

********** Link: CAVFS N ********** Link Inflow Frequency Stats
Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	7.083E-02
5-Year	9.197E-02
10-Year	0.103
25-Year	0.131
50-Year	0.166
100-Year	0.192
200-Year	0.199

********** Link: CAVFS N ********** Link Outflow 1 Frequency Stats
Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	7.011E-02
5-Year	9.184E-02
10-Year	0.107
25-Year	0.116
50-Year	0.137
100-Year	0.163
200-Year	0.220

********** Link: StormChamber N ********** Link Inflow Frequency Stats
Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	7.011E-02
5-Year	9.184E-02
10-Year	0.107
25-Year	0.116
50-Year	0.137
100-Year	0.163

200-Year	0.220

********** Link: StormChamber N ********** Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	7.888E-03
5-Year	9.531E-03
10-Year	1.360E-02
25-Year	2.069E-02
50-Year	4.652E-02
100-Year	8.901E-02
200-Year	9.066E-02

********** Link: StormChamber N ********** Link WSEL Stats

WSEL Frequency Data(ft)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	100.761
1.11-Year	100.831
1.25-Year	100.991
2.00-Year	101.398
3.33-Year	101.709
5-Year	102.041
10-Year	102.408
25-Year	102.993
50-Year	103.014
100-Year	103.027

********** Link: Bioretention Planter S ********** Link Inflow Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.099E-02
5-Year	5.325E-02
10-Year	5.990E-02
25-Year	7.540E-02
50-Year	9.598E-02
100-Year	0.111
200-Year	0.115

********** Link: Bioretention Planter S ********** Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	3.569E-02
5-Year	4.677E-02
10-Year	5.665E-02
25-Year	6.391E-02
50-Year	8.301E-02
100-Year	9.773E-02
200-Year	0.111

********** Link: Bioretention Planter S ********** Link WSEL Stats

WSEL Frequency Data(ft)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	101.018
1.11-Year	101.020
1.25-Year	101.023
2.00-Year	101.033
3.33-Year	101.038
5-Year	101.040
10-Year	101.046
25-Year	101.050
50-Year	101.061
100-Year	101.068

********** Link: POC Inflow ********** Link Inflow Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.962E-02
5-Year	6.503E-02
10-Year	7.630E-02
25-Year	9.210E-02
50-Year	0.135
100-Year	0.150
200-Year	0.151

************Groundwater Recharge Summary **************

Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Site N and Mod	32.762
Subbasin: Flow Through	9.958
Subbasin: Bypass Area	0.000
Link: POC 0.000	
Total:	42.720

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Target Area N	0.000
Subbasin: Flow Through N	9.958
Subbasin: Addition (Bypass)	0.000
Subbasin: Play Area (Bypass)	0.000
Link: CAVFS N	0.000
Link: StormChamber N	0.000
Link: Bioretention Planter	0.000
Link: POC Inflow	0.000
Total:	9.958

Total Predevelopment Recharge is Greater than Post Developed
Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.270 ac-ft/year, Post Developed: 0.063 ac-ft/year

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

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

Number of Links: 1

********** Link: POC **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 94.88
Inflow Volume Including PPT-Evap (ac-ft): 94.88
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 94.88
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

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

Number of Links: 4

********** Link: CAVFS N **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 85.21
Inflow Volume Including PPT-Evap (ac-ft): 92.06
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 49.85, 54.15%
Primary Outflow To Downstream System (ac-ft): 92.19
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 54.15%

********** Link: StormChamber N **********

Basic Wet Pond Volume (91% Exceedance): 846. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1268. cu-ft

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 92.19
Inflow Volume Including PPT-Evap (ac-ft): 92.19
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 92.19
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

********** Link: Bioretention Planter S **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 49.32
Inflow Volume Including PPT-Evap (ac-ft): 50.51
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 46.64, 92.33%
Primary Outflow To Downstream System (ac-ft): 50.56
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 92.33%

********** Link: POC Inflow **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 156.20
Inflow Volume Including PPT-Evap (ac-ft): 156.20
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 156.20
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

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

Scenario Predeveloped Compliance Link: POC
Scenario Postdeveloped Compliance Link: POC Inflow

***** 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	6.647E-02	2-Year	4.962E-02
5-Year	8.461E-02	5-Year	6.503E-02
10-Year	0.101	10-Year	7.630E-02
25-Year	0.133	25-Year	9.210E-02
50-Year	0.158	50-Year	0.135
100-Year	0.177	100-Year	0.150
200-Year	0.182	200-Year	0.151

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

****** Flow Duration Performance ******

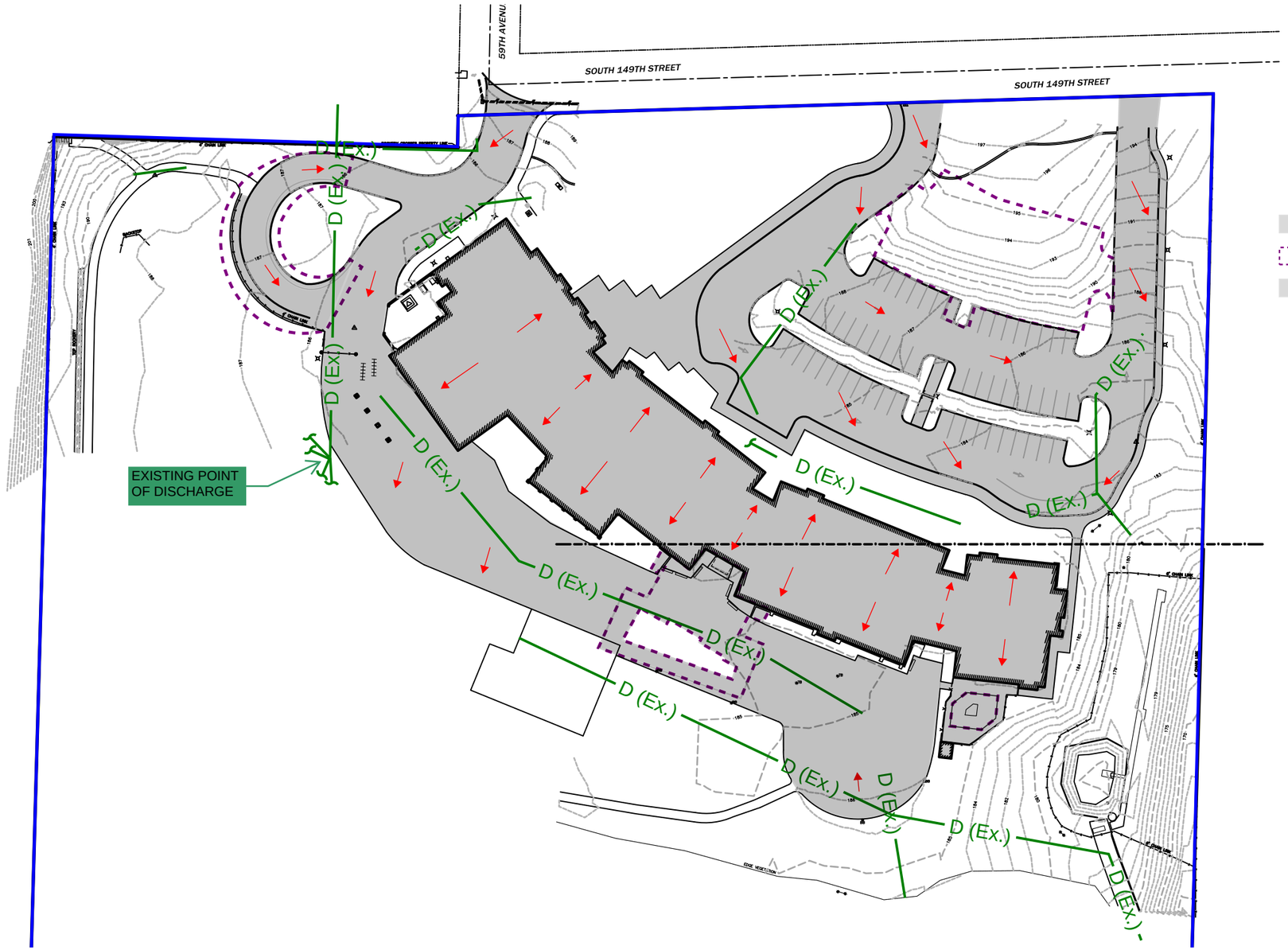
Excursion at Predeveloped 50%Q2 (Must be Less Than or Equal to 0%):	-58.1%	PASS
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than or Equal to 0%):	-56.4%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-18.7%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS

****** LID Duration Performance ******

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	67.9%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	64.3%	FAIL

LID DURATION DESIGN CRITERIA: FAIL



Legend

Description	Quantity	Unit
Non-Target Impervious Area	2.96	ac
Project Site Area	0.52	ac
Target Impervious Area	0.13	ac

N

GRAPHIC SCALE

0 40 80 160

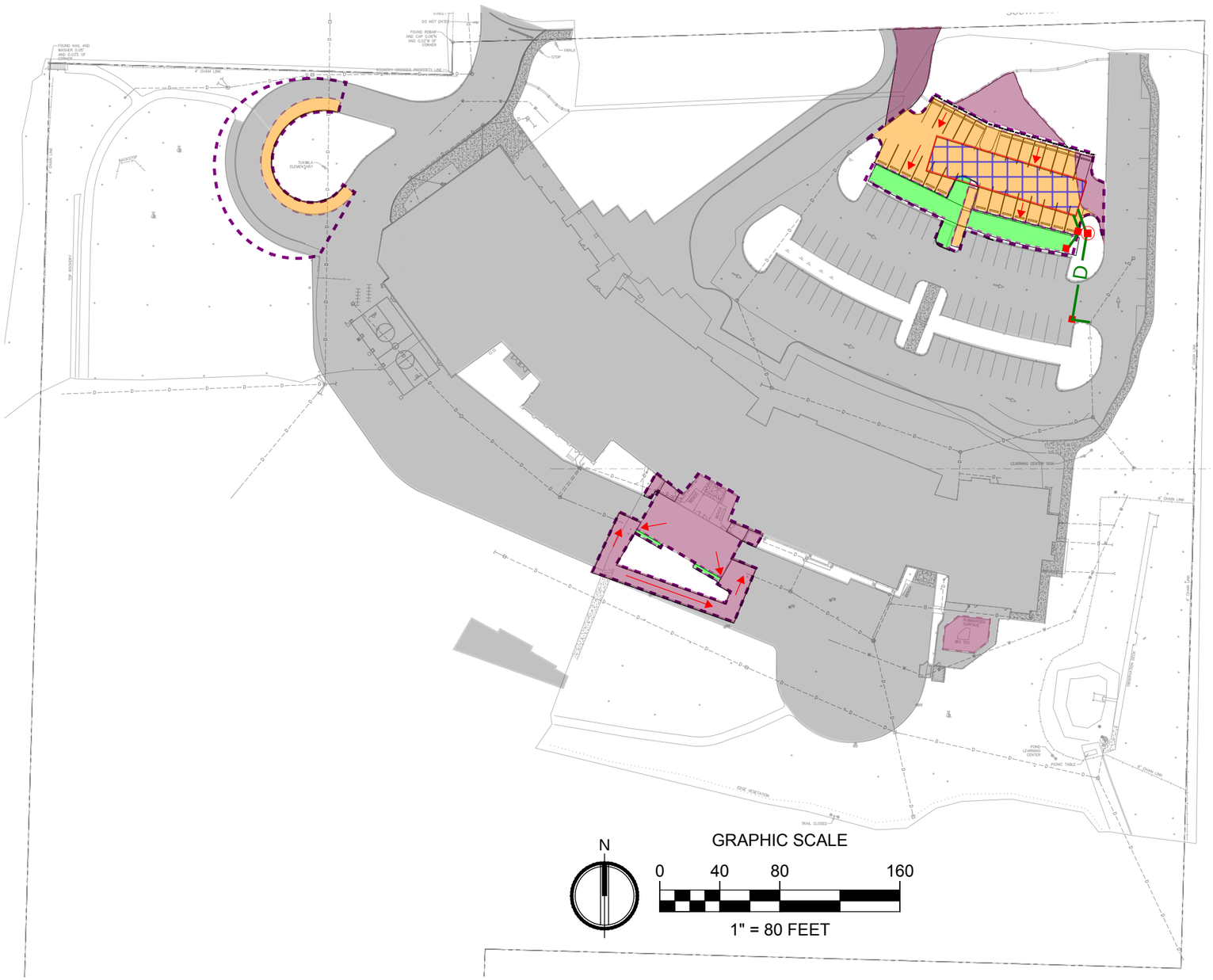
1" = 80 FEET

AHBL
1200 6th Avenue
Suite 1620
Seattle, WA 98101
206.267.2425 TEL
206.267.2429 FAX

TUKWILA ELEMENTARY SCHOOL ADDITION

EXISTING CONDITIONS MAP

EXHIBIT 4-2



AHBL
1200 6th Avenue
Suite 1620
Seattle, WA 98101
206.267.2425 TEL
206.267.2429 FAX

TUKWILA ELEMENTARY SCHOOL

DEVELOPED CONDITIONS MAP

EXHIBIT 1-4

Section 5.0 Attachments

(To be included in Final Submittal)

Section 6.0 Attachments

Exhibit 6-1 ..... Geotechnical Report
Exhibit 6-2 ..... Gilliam Creek Basin Stormwater Management Plan

SUBMITTED TO:
KMB Architects
906 Columbia Street SW,
Suite 400
Olympia, WA 98501

BY:
Shannon & Wilson, Inc.
400 N. 34th St., Suite 100
Seattle, WA 98103

(206) 632-8020
www.shannonwilson.com

PRELIMINARY GEOTECHNICAL REPORT

Tukwila Elementary School Renovations and Modulars

TUKWILA, WASHINGTON

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

August 27, 2018

Shannon & Wilson No. 101258-001

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Tukwila Elementary School
Renovations and Modulars
Tukwila, Washington

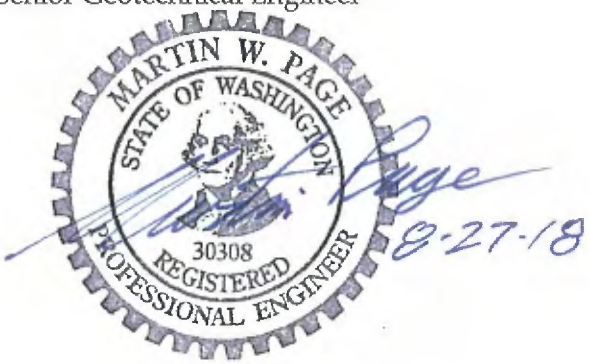
Preliminary Geotechnical Report

Shannon & Wilson participated in this project as a consultant to Tukwila School District and KMB Architects. Our scope of services was authorized by Tukwila School District Purchase Order Number 2031718053 dated July 30, 2018.

This report was prepared and reviewed by:

Genevieve N. Fujimoto

Genevieve N. Fujimoto, PE
Senior Geotechnical Engineer



8-27-18

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GNF:MWP/gnf

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ACRONYMS

bgs	below ground surface
Ecology	Washington State Department of Ecology
IBC	International Building Code
pcf	pounds per cubic foot
PGA	peak ground acceleration
PIT	pilot infiltration pit
psf	pounds per square inch
Qvrl	Quaternary recessional lacustrine deposits
Qvt	Quaternary Vashon till
Tpr	Tertiary Renton Formation
WSDOT	Washington State Department of Transportation
WWSWMM	Western Washington Stormwater Management Manual

1 SITE AND PROJECT DESCRIPTION

We understand that the Tukwila School District plans to perform renovations and construct modular unit additions at the existing Tukwila Elementary School property. Tukwila Elementary School is located south of South 149th Street between 59th Avenue South and 62nd Avenue South in Tukwila, Washington, as shown on the Vicinity Map (Figure 1). The renovations will consist of expanding the existing parking lot and bus loop to accommodate more vehicles and school buses. The District also plans to add two modular units south and southwest of the existing playground area to provide additional classrooms.

The purpose of this study is to perform a preliminary evaluation of the subsurface conditions to help facilitate the site selection and conceptual design process. Our scope of services included excavating six test pits around the property to evaluate the soil conditions and perform a pilot infiltration test (PIT) to evaluate stormwater infiltration rates. Laboratory testing was performed to determine the water content and grain size distribution or plasticity of representative soil samples from the parking lot, bus loop, and two modular unit locations. Authorization to perform this work was provided by KMB Architects with a signed proposal submitted on July 23, 2018.

This report presents the preliminary geotechnical engineering findings at the site. We have included our recommendations regarding infiltration, foundations, seismic design, lateral earth pressures, earthwork, and construction considerations in this report.

2 SITE CONDITIONS

2.1 Regional Geology

The site is located in Tukwila, Washington, which is within a region known as the Puget Lowland. The Puget Lowland is a structural depression bordered by the Olympic and Cascade Mountain ranges that is generally within about 500 feet of sea level. The geology of the area has been influenced by repeated cycles of glaciation, which worked to fill the lowland to significant depths with a complex sequence of glacial and nonglacial deposits. The most recent glacier to impact the area, the Vashon Stade of the Fraser Glaciation, overrode the area with up to 3,000 feet of ice in some locations.

The mapped geology indicates that the project site is underlain by Quaternary Vashon till (Qvt) and Tertiary Renton Formation (Tpr) bedrock of Eocene age. The Qvt unit is

characterized by dense to very dense sands and gravels with variable amounts of silt, and cobble- to boulder-size material is common within this unit. The Tpr unit consists of sandstone as well as some siltstone, sandy shale, coal, and carbonaceous shale. The bedrock is mostly light gray but oxidizes to light brown to pale orange-brown. Sandstone of the Renton formation is typically weakly cemented and massive (Booth and Waldron, 2004).

Quaternary recessional lacustrine deposits (Qvrl) are located south and west of the project site. The Qvrl unit consists of very fine-grained sand, silt, and clay. Soils within this unit were deposited in small lakes during the ice recession and are typically not overconsolidated like the Qvt unit (Booth and Waldron, 2004).

2.2 Regional Seismicity

The Puget Sound Lowland is located in the forearc of the Cascadia Subduction Zone. The seismicity of the region is largely derived from the subduction of the Juan de Fuca Plate beneath the North American Plate. The seismic hazard of the region comes from three major sources: major subduction-type events, deep intraplate events (such as the 2001 Nisqually earthquake), and earthquakes due to rupture of shallow crustal faults.

The site itself is located a reasonable distance from subduction and intraslab sources, and as a result, the more local, crustal faults are believed to drive the seismic hazard for the site. The closest known active fault to the site is the Seattle Fault. The Seattle Fault is a shallow, east-west-trending thrust fault that is believed to be capable of producing a magnitude 7 event, which could impose significant seismic demands at the site.

3 SUBSURFACE EXPLORATION

Clearcreek Contractors, under subcontract to Shannon & Wilson, excavated seven test pits between August 7 and 8, 2018. A Shannon & Wilson representative was on site to observe the excavation, collect soil samples, and perform infiltration testing. The approximate test pit locations are shown in the Site and Exploration Plan, Figure 2. All test pits were located in grass areas and Clearcreek used a mini excavator with rubber treads to minimize disturbance to the site. Each test pit was backfilled with the excavated soil immediately after the excavation or infiltration testing was complete.

Test pits TP-1 through TP-6 were excavated on August 7, 2018, at the proposed locations of the expanded parking lot, bus loop, and new modular units, to evaluate soil conditions. The test pit depths ranged from 2.5 and 7 feet below ground surface (bgs).

On August 8, 2018, Clearcreek excavated test pit PIT-1 to a depth of 3 feet bgs for the PIT. PIT-1 was excavated adjacent to TP-1 near the existing bus loop (Figure 2). We performed the PIT using the small-scale method described in the Western Washington Stormwater Management Manual (WWSWMM) (Washington State Department of Ecology [Ecology], 2014). The test pit dimensions were approximately 2 by 7 feet at the bottom of the pit and 2 by 8.7 feet at the ground surface. We provide a graph of the PIT results from our manual and datalogger readings in Figure 3.

Detailed soil conditions from our exploration are presented in the test pit logs included in Appendix A. The surface elevations shown on the logs are estimated based on the record drawings for the school (Bassetti, 2001). It is expected that the test pit locations and surface elevations can be updated after the site topographic survey is available.

4 LABORATORY TESTING

Laboratory testing was conducted on several soil samples collected from the test pits to assist in classification and characterization of the subsurface soils. The laboratory tests include natural moisture content determinations, grain size analyses, and Atterberg Limits. The natural moisture contents are indicated in the test pit logs in Appendix A. The results of the grain size analyses are presented in Appendix B.

5 SUBSURFACE CONDITIONS

5.1 Site Geology and Subsurface Conditions

Our initial explorations indicate that the site is covered with a thin layer of topsoil that is underlain by reworked or native material. The reworked material consists of glacial till that was likely placed as fill during previous grading operations at the site. We also encountered glacial till and a clay deposit that appeared to be native material. The clay deposit was only encountered at one test pit location (TP-5) and overlain by approximately 1 foot of sandy silt fill.

We characterize the reworked and native glacial till as being a medium dense to very dense, clayey sand with gravel and some cobbles. We characterize the clay deposit at TP-5 as stiff, high plasticity or fat clay. Contaminated soils were not found in any of the test pits that were dug.

Grain size analyses of the till material indicated that the till soils contain approximately 32 percent of fines. Use of the on-site soils for backfilling is discussed in Section 6.6.

5.2 Hydrogeologic Conditions

Groundwater was not encountered during the explorations. However, we observed a small area of seepage in the test pit wall in TP-2, as well as iron oxide staining in soils from most of the test pits, which indicates that water was previously present. Therefore, perched water may be encountered within the fill material overlying native glacial till and clay. Perched water is more likely to be present during the wet winter/spring months.

5.3 Infiltration Potential

We measured infiltration rates between approximately 0.1 and 0.3 inch per hour during the PIT, as shown in Figure 3. In accordance with the WWSWMM, we recommend a partial correction factor of 0.50 and a design infiltration rate of 0.05 inch per hour (Ecology, 2014). The design infiltration rate is not conducive for an infiltration system onsite. Therefore, we recommend the use of an on-site detention facility to manage stormwater runoff from the proposed site improvements.

6 ENGINEERING STUDIES AND PRELIMINARY RECOMMENDATIONS

6.1 General

We understand the proposed renovations and modular units will consist of new pavement for the expanded parking lot and bus loop and new concrete pads for the modular units. Based on the observations made during the subsurface exploration program, we expect the glacial till material will provide good support for the pavement and concrete pads with minimal settlements. The clay deposit at TP-5 should provide sufficient support for a concrete pad supporting the proposed modular unit provided the bearing pressure of the structure is relatively low. In all areas, some overexcavation may be necessary to remove unsuitable fills and to provide a suitable subgrade for the pavement and concrete pads.

The following subsections provide detailed recommendations on the following topics:

- Foundation design
- Seismic design
- Lateral earth pressures

- Lateral resistance
- Earthwork and use of on-site soils

6.2 Foundation Design

We recommend an allowable bearing capacity of 2,000 pounds per square foot (psf) for concrete pads founded on native or reworked glacial till. For areas underlain by clay, we recommend an allowable bearing capacity of 1,700 psf. Concrete pads that are founded on compacted structural backfill placed above the glacial till may also be designed for an allowable bearing capacity of 2,000 psf.

The allowable bearing pressure for footing design may be increased by one-third for short-term seismic loads. Any fill material that is to be reused should be evaluated by a geotechnical engineer to see if it is suitable for use. Loose fills will require in situ densification with a heavy plate compactor (Hoe-Pac).

For concrete pads founded on till material, we estimate the settlement will be less than a ½ inch.

6.3 Seismic Design

The seismic design of the structure should be in accordance with the International Building Code (IBC) 2015 (International Code Council, 2014). The IBC design criteria are based on a target risk of structural collapse of 2 percent in 50 years. The soil profile is assessed by assigning a site class definition. It is our opinion that based on the soil classifications, the site can be classified as Site Class D.

Seismic inputs are the short-period maximum spectra acceleration, S_S, and spectral acceleration at a period of one second, S_1. Using the map provided in the IBC, which corresponds to Site Class B sites, the mapped values of S_S and S_1 are approximately 1.467 and 0.548 g, respectively. The site coefficients for the given spectral acceleration values and Site Class D are 1.0 and 1.5 for Fa and Fv, respectively. Seismic hazards, such as liquefaction and fault rupture, are not expected at this project site.

6.4 Lateral Earth Pressures

Lateral earth pressures will act on retaining walls and rockery walls as well as portions of spread footing foundations if used. The magnitude and distribution of these lateral pressures will depend on many factors, including but not limited to, the type of backfill, the method of backfill placement, level of backfill compaction, slope of backfill, drainage, and characteristics of the wall itself. If the wall is allowed to move at least 0.001 time the wall

height, the wall is considered flexible and active earth pressures can be used. If the wall is considered to be inflexible, then at-rest earth pressures must be used.

The active and at-rest earth pressures, evaluated using an equivalent fluid unit weight, are estimated to be on the order of 35 and 55 pounds per cubic feet (pcf), respectively. The values given above assume a permanent wall structure, the ground surface behind the wall is level, and that proper drainage is installed to prevent the buildup of pore water pressure behind the wall. The total earth pressures should be analyzed for seismic loading conditions using a dynamic load increment equal to a percentage of the static earth force. The percentage load increase for seismic conditions was developed to be consistent with a pseudo-static analysis using the Mononobe-Okabe equation for lateral earth pressures (Kramer, 1996) and a horizontal seismic coefficient of 0.33. The load increase for seismic conditions is recommended to be a uniformly distributed load equal to 15H, where H is the height of the wall. Note the seismic coefficient is not equal to the peak ground acceleration (PGA) expected to be encountered at the site in a design event. The PGA is experienced only a few times within the record of earthquake shaking, and the actual earthquake ground motion is cyclic in nature, not static. Values of the seismic coefficient are thus typically one-third to one-half the value of the PGA that may be experienced at the site during a design-level event.

6.5 Lateral Resistance

Footings may resist lateral loads using a combination of base friction and passive pressure against the buried or embedded portion of the footings and buried wall. We recommend that base sliding resistance be determined using an allowable coefficient of friction of 0.4 for a concrete foundation founded on the on-site glacial till or compacted structural fill. For concrete foundations founded on the on-site clay, we recommend an allowable coefficient of friction of 0.2. Passive earth pressures can be evaluated using an equivalent unit weight of 290 pcf. The values above include a factor of safety of 1.5.

6.6 Earthwork and Use of On-Site Soils

Soils with high fines content (greater than 30 percent) may be or may become loose, unstable, and difficult to work with, especially during wet season grading. The on-site clay should not be used for structural fill. The native glacial till soils with up to 41 percent fines are moisture sensitive but may be suitable for use as structural fill if the moisture content can be controlled, i.e., during the dry summer months. The on-site glacial till soils may be used as structural fill material provided the following conditions are met:

- The soil is free from organics, debris, or other deleterious material.

- The water content of the on-site soil at the time of compaction is close to its optimum as determined by a Modified Proctor Test (ASTM, 2015).
- On-site soils used for fills and backfills that become wet and unstable after placement should be removed and replaced with suitable material.
- Stockpiled on-site soils are protected with plastic sheeting when rainfall is anticipated.

If on-site soil becomes too difficult to compact or construction site space limitations prevent stockpiling, we recommend using imported, granular structural backfill. Imported structural backfill should meet the gradation requirements of Section 9-03.14(1), Gravel Borrow, of the 2014 Washington State Department of Transportation (WSDOT) Standard Specifications (WSDOT, 2014). If fill is to be placed during periods of wet weather or under wet conditions, it should have the added requirement that the percentage of fines (material passing the No. 200 sieve based on wet-sieving the minus ¾-inch fraction) be limited to 5 percent. All fines should be non-plastic.

Fill placed beneath structures such as floor slabs, pavements, sidewalks, or backfill against footings should be structural fill. Structural fill should be placed and compacted upon native soil surfaces observed during construction by a geotechnical engineer or the engineer's representative. Structural fill should be placed in horizontal, uniform lifts and compacted to a dense and unyielding condition, and to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557) (ASTM, 2015). Subgrades to receive structural fill should be dense and unyielding and should be evaluated by the geotechnical engineer prior to the placement of fill. In general, the thickness of soil layers before compaction should not exceed 10 inches for heavy equipment compactors or 6 inches for hand-operated mechanical compactors. The most appropriate lift thickness should be determined in the field using the Contractor's selected equipment and fill and verified with in situ soil density testing (nuclear gauge methods). All compacted surfaces should be sloped to drain to prevent ponding. Structural fill operations should be observed and evaluated by an experienced geotechnical engineer or technician.

7 ADDITIONAL STUDIES

We recommend that the project design team review this preliminary report and advise us if additional explorations and design studies need to be performed. Additional test pits at or near the proposed structure locations may be appropriate. The number and type of explorations will depend on the type of structure, location within the site, and proximity to existing explorations, as well as other factors.

8 LIMITATIONS

This report was prepared for the exclusive use of the Tukwila School District and KMB Architects for specific application to the design of the Tukwila Elementary School Renovations and Modulars project as it relates to the geotechnical aspects discussed in this report. The data and report should be provided to prospective contractors and/or the Contractor for factual information only. Our judgments, conclusions, and interpretations presented in the report should not be construed as a warranty of subsurface conditions and should not be relied upon by prospective contractors. Construction period observation by our firm is necessary to confirm preliminary recommendations and interpretations made in this report.

9 REFERENCES

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0 2,000 4,000

Approximate Scale in Feet

NOTE

Bing Map Image adapted from aerial imagery provided by Autodesk Live Maps and Microsoft Bing Maps reprinted with permission from Microsoft Corporation.

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Tukwila Elementary School Renovations
Tukwila, Washington

VICINITY MAP

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FIG. 1

Filename: J:_SEA\101258\001\101258-001 Vicinity Map.dwg Date: 08-13-2018 Login: jrs

Filename: J:_SEA\101258\001\101258-001 Plan.dwg Layout: Figure 2 Date: 08-21-2018 Login: sac

0 120 240

Scale in Feet

NOTE

Bing Map Image adapted from aerial imagery provided by Autodesk Live Maps and Microsoft Bing Maps reprinted with permission from Microsoft Corporation.

LEGEND

TP-1 Test Pit Designation and Approximate Location

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SITE AND EXPLORATION PLAN

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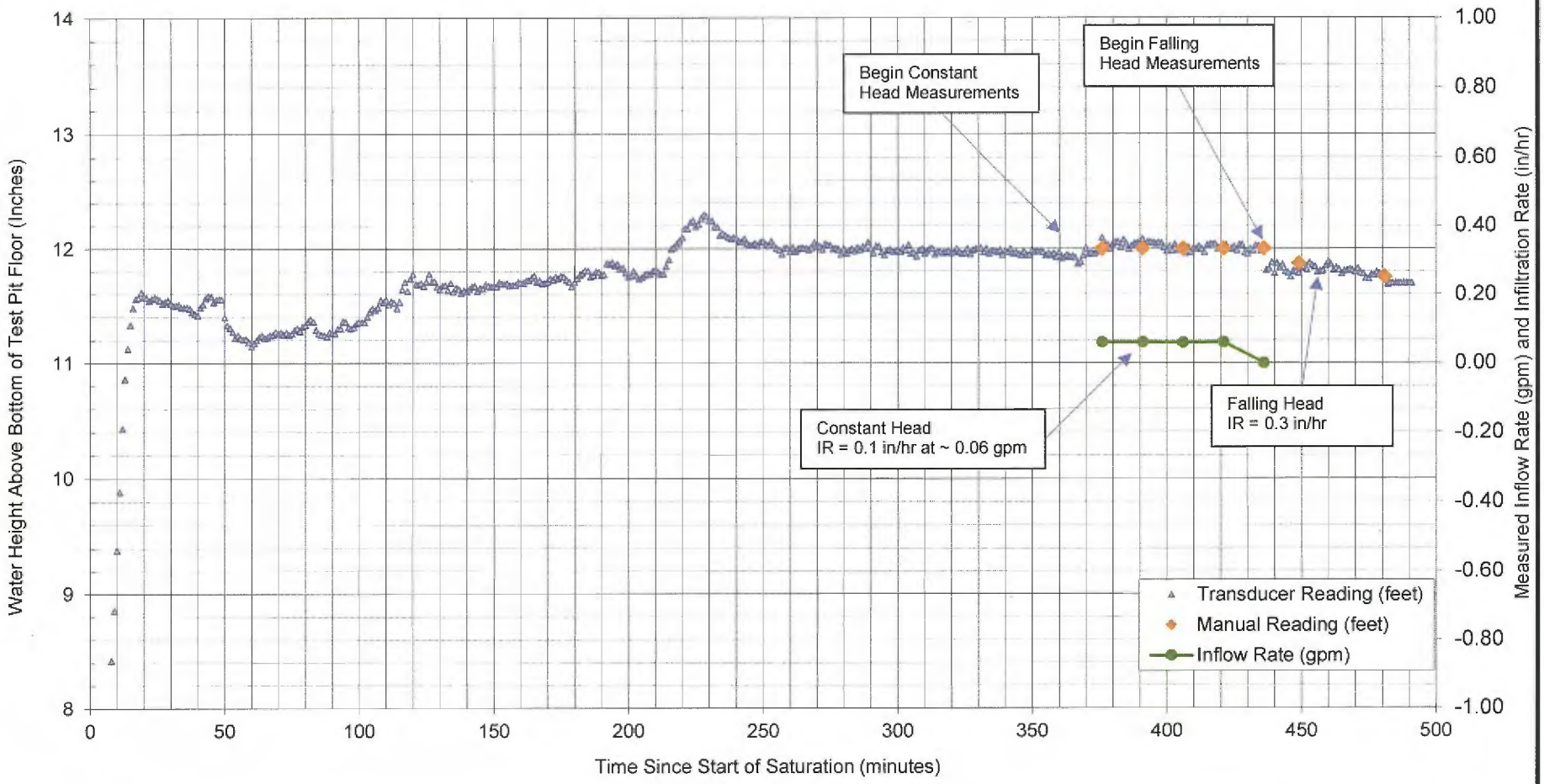
FIG. 2

FIG. 2

File: Tukwila_Test_Pit Date: 8/21/2018 Author: PVH



NOTES

1. This small-scale pilot infiltration test (PIT) was performed on August 8, 2018. Water was added to the pit from approximately 07:30 to 15:00. The surface grade elevation was approximately 187.5 feet. The water level was approximately 12 inches above the bottom of the pit during the PIT. A flow rate of 0.01 to 0.06 gpm and water level of approximately 11.8 to 11.9 inches was maintained during the last hour of saturation for the constant head test. After this period, the falling head test was conducted between 15:00 and 15:45. At the conclusion of the test, the pit did not drain and was dewatered using a sump pump. The test pit dimensions during the PIT were approximately 2 feet by 7 feet at the bottom of the pit and 2 feet by 8.7 feet at the ground surface. The bottom of the test pit is estimated to be approximately 14 square feet.
2. gpm = gallons per minute, in/hr = inches per hour, IR = measured infiltration rate

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TEST PIT PIT-1
PILOT INFILTRATION TEST DATA

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FIG. 3

FIG. 3

APPENDIX A: TEST PIT LOGS

Appendix A

Test Pit Logs

CONTENTS

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor.*
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

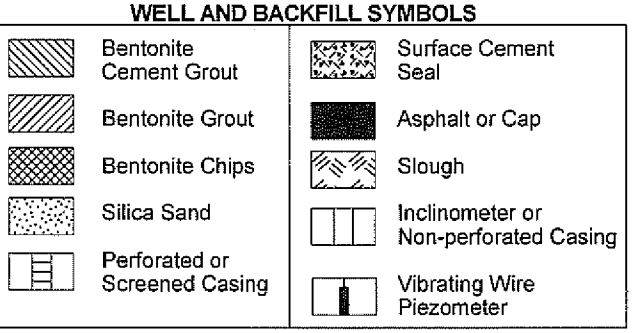
PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS



PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 1 of 3

SOIL_CLASS_KEY_PG1 101258.GPJ SHAN_WIL.GDT 8/22/18

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW		Well-Graded Gravel; Well-Graded Gravel with Sand
			GP		Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM		Silty Gravel; Silty Gravel with Sand
			GC		Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW		Well-Graded Sand; Well-Graded Sand with Gravel
			SP		Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM		Silty Sand; Silty Sand with Gravel
			SC		Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL		Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH		Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH		Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT		Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

Tukwila Elementary School
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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 2 of 3

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICITY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[2]Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

Tukwila Elementary School
Tukwila, Washington

SOIL DESCRIPTION AND LOG KEY

August 2018 101258-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 3 of 3

SOIL_CLASS_KEY_PG3_101258.GPJ SHAN_WIL.GDT 8/22/18

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-1

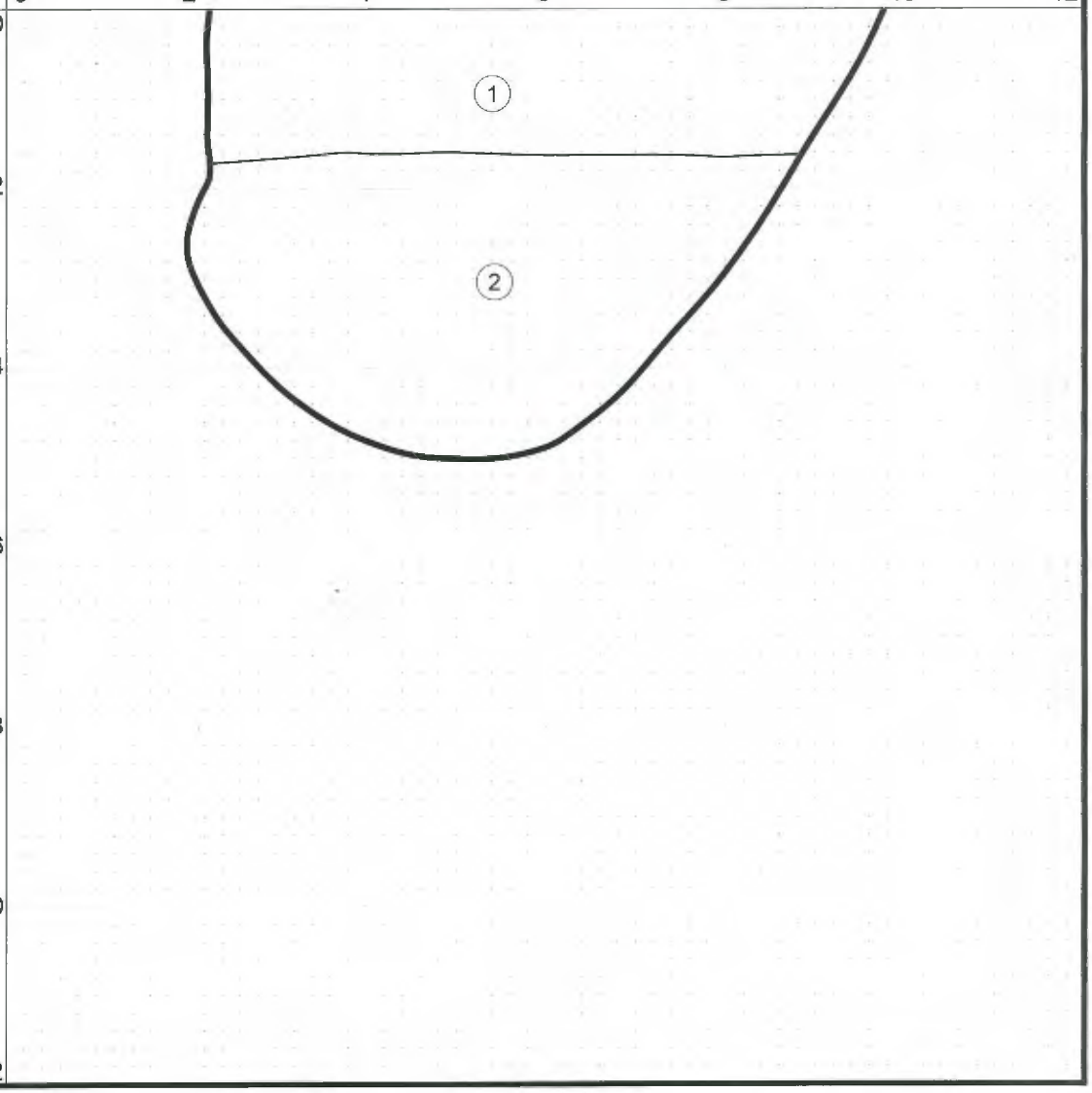
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Bus Loop Extension

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass (1) Soft to medium stiff, brown, *Sandy Silt (ML)*; moist. (2) Dense to very dense, brown, *Clayey Sand with Gravel (SC)*; moist; cobbles; low to medium plasticity fines; trace iron-oxide staining. Till (Qvt) - 1.5 feet: Difficult to excavate. Terminated at 5 feet.	None Observed		S-1	0 2 4 6 8 10 12

Sketch of North Pit Side

Surface Elevation: Approx. 187.5 Ft.



NOTE

Dimensions: 2 feet x 8 feet.

FIG. A-2

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

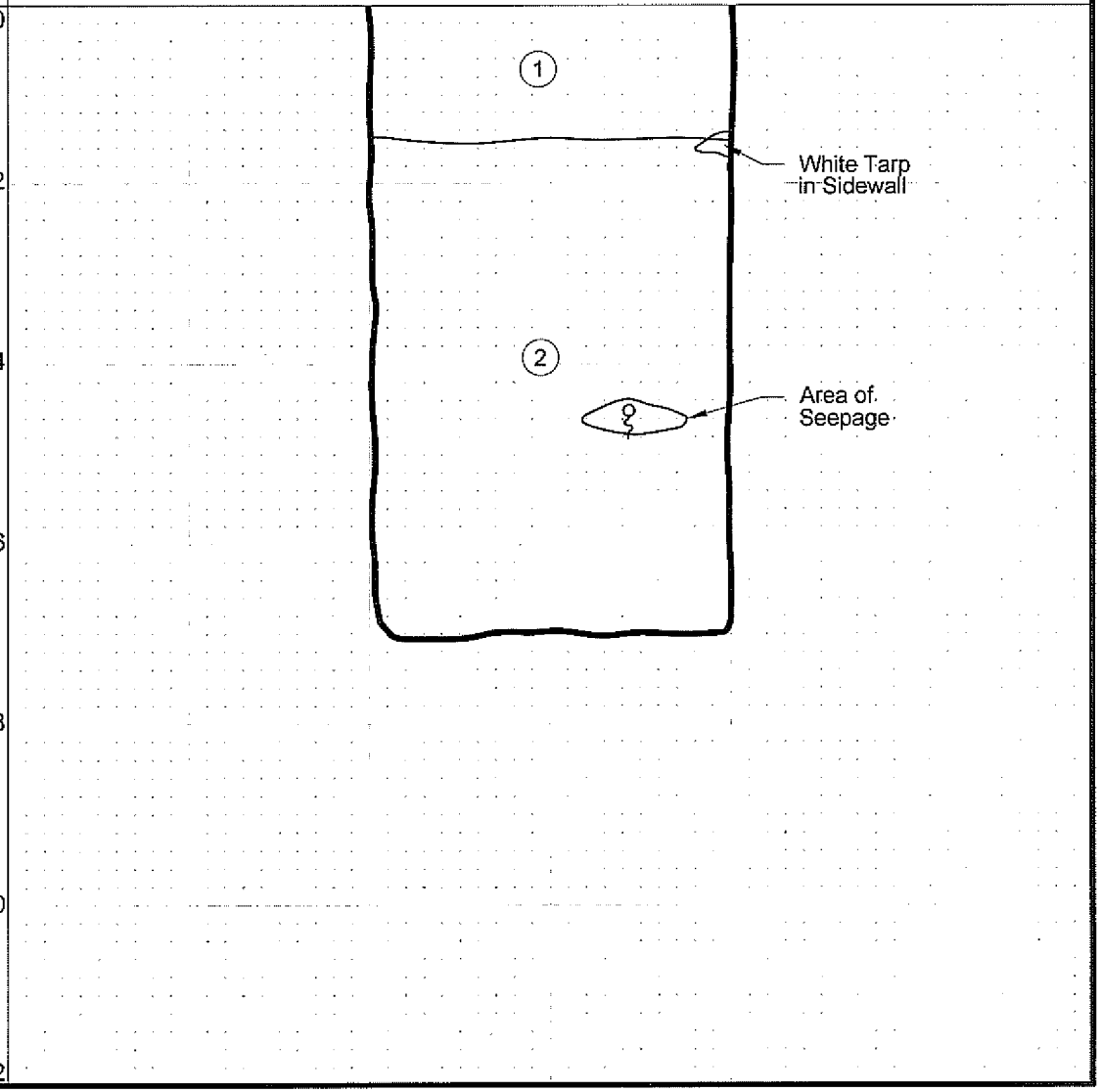
LOG OF TEST PIT TP-2

JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Bus Loop Extension

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass (1) Soft, brown, *Silty to Clayey Sand (SM/SC)*; moist; few fine to coarse gravel; trace cobbles; clay pockets. Fill (Hf) - Roots in upper 6 inches. - 2 feet: Difficult to excavate. 12" cobbles excavated. (2) Medium dense to very dense, brown and gray, *Clayey Sand with Gravel (SC)*; moist to wet; cobbles; 3" diameter piece of concrete; clay pockets; trace iron-oxide staining locally. Terminated at 7 feet.	▽		S-1	0 2 4 6 8 10 12

Sketch of Southeast Pit Side — Surface Elevation: Approx. 188 Ft.



NOTE

Dimensions: 2 feet x 7 feet.

FIG. A-3

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-3

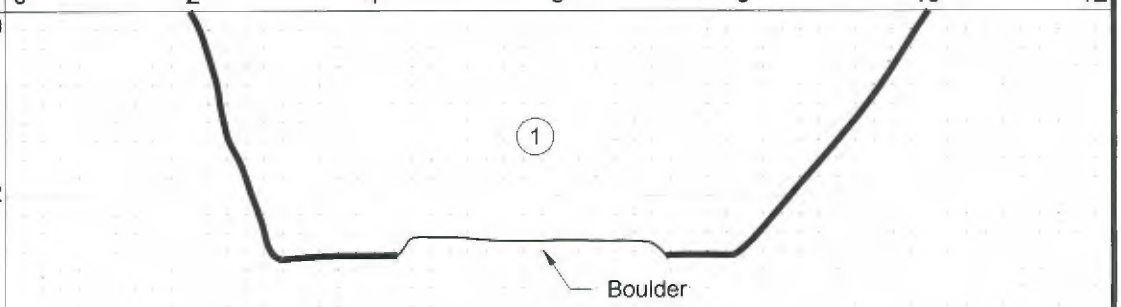
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Parking Lot

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass (1) Light brown, *Silty Sand with Gravel (SM)* to *Clayey Sand (SC)*; moist; trace cobbles; tree roots in upper 1.5 feet. Weathered Till and Till (Qvt) - 2 feet: Difficult to excavate. - 2.5 feet: Boulder or bedrock, gray, 1 foot x 2 feet exposed. Terminated at 2.5 feet due to boulder.	None Observed		S-1	0 2 4 6 8 10 12

Sketch of Northwest Pit Side

Surface Elevation: Approx. 194 Ft.



NOTE

Dimensions: 2.5 feet x 8 feet.

FIG. A-4

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-4

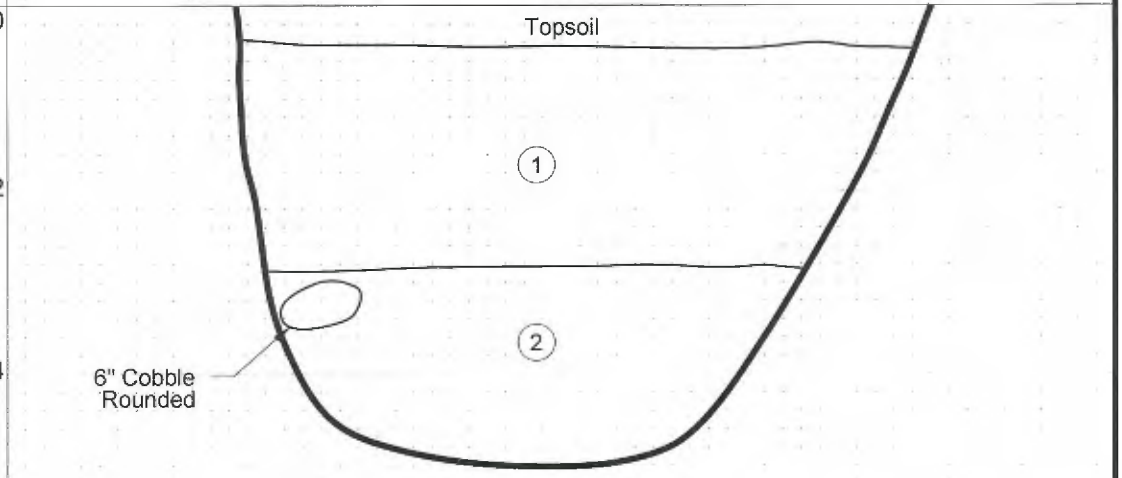
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Parking Lot

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
4" Grass and topsoil	None Observed			0
(1) Brown; *Silty Sand (SM)*; moist; coarse subangular to subrounded gravel; compacted; tree roots in upper 6 inches.				
(2) Dense, gray and brown, *Clayey Sand with Gravel (SC)*; moist; cobbles; low to medium plasticity fines. Till (Qvt)				2
- 3 feet: Difficult to excavate.				
Terminated at 5 feet.		11.8	S-1	4
				6
				8
				10
				12

Sketch of North Pit Side

Surface Elevation: Approx. 191 Ft.



NOTE

Dimensions: 2 feet x 7.5 feet.

FIG. A-5

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-5

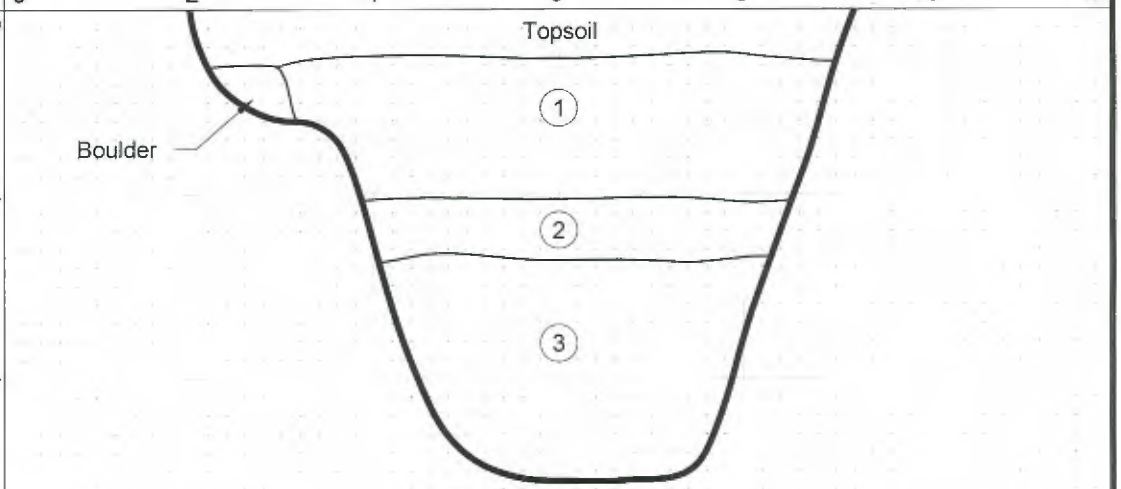
JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: Adjacent to Playground

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
4" Grass and topsoil	None Observed			0
(1) Loose, brown, *Silty to Clayey Sand with Gravel (SM/SC)*; moist; coarse gravel; roots in upper 6 inches. Fill or Reworked Earth (Hf)				
- 1' on south end of test pit, large boulder.				2
(2) Stiff, dark brown and red, *Silt (ML) to Lean Clay (CL)*; moist; fissured; organics; iron oxide stained. Holocene Lacustrine Deposits (Hl)				
(3) Stiff, gray, *Fat Clay (CH)*; moist; trace gravel; few fine sand pockets; high plasticity fines; organics and roots. Lacustrine Deposits (Qvrl)			S-1	4
Terminated at 5 feet.				6
				8
				10
				12

Sketch of West Pit Side

Surface Elevation: Approx. 185.5 Ft.



NOTE

Dimensions: 2 feet x 5 feet.

FIG. A-6

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

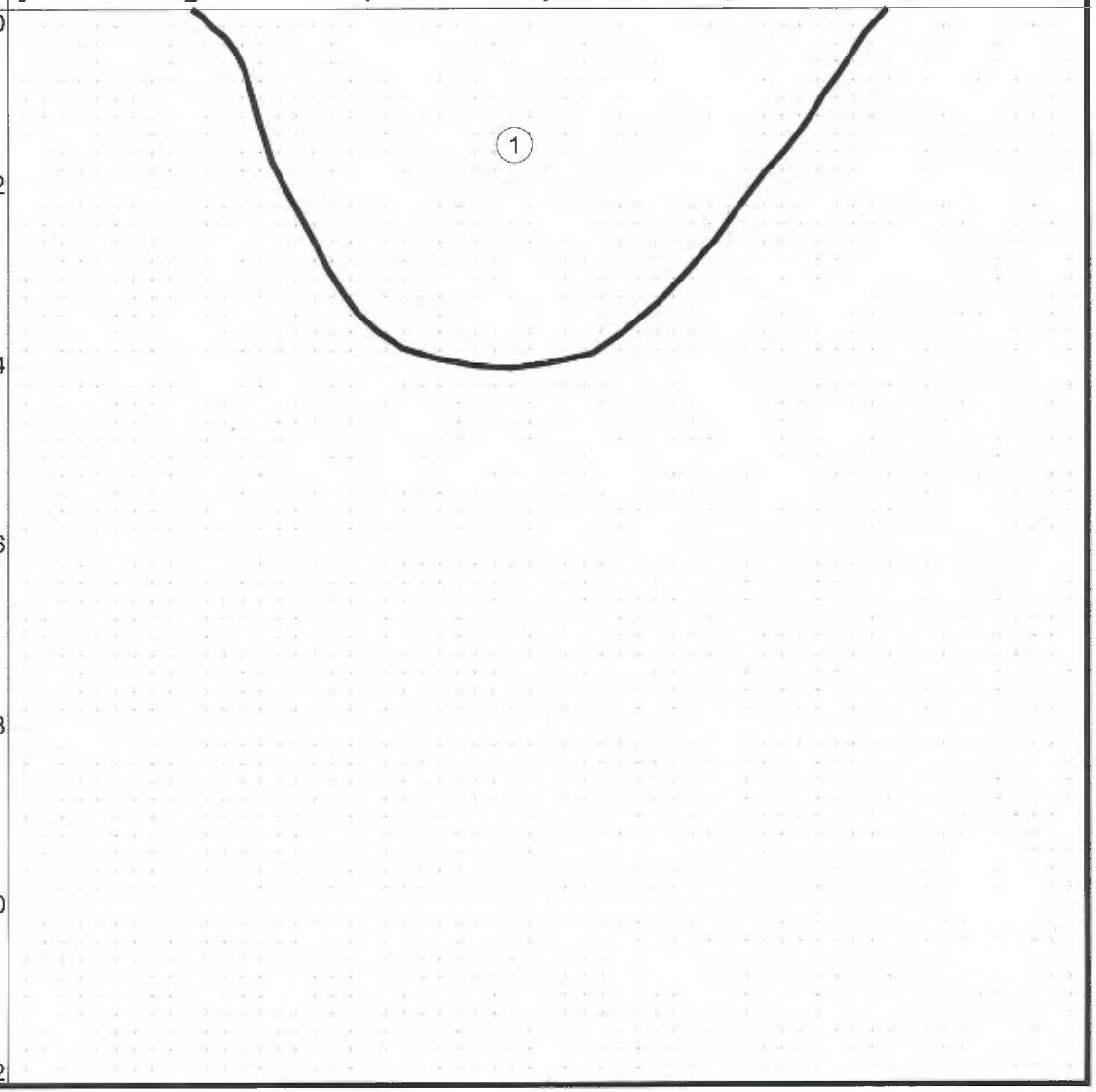
LOG OF TEST PIT TP-6

JOB NO: 101258-001 DATE: 8-7-2018 LOCATION: East of Playground

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass (1) Medium dense to dense, brown, *Clayey Sand with Gravel (SC)*; moist; subangular to subrounded coarse gravel; few cobbles; low to medium plasticity fines; tree roots in upper 6 inches and at 2 feet. Weathered Till and Till (Qvt) - 3.5 feet: Difficult to excavate. Terminated at 4 feet.	None Observed		S-1	0 2 4 6 8 10 12

Sketch of East Pit Side — Surface Elevation: Approx. 185.5 Ft.



NOTE

Dimensions: 2 feet x 8 feet.

FIG. A-7

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT PIT-1

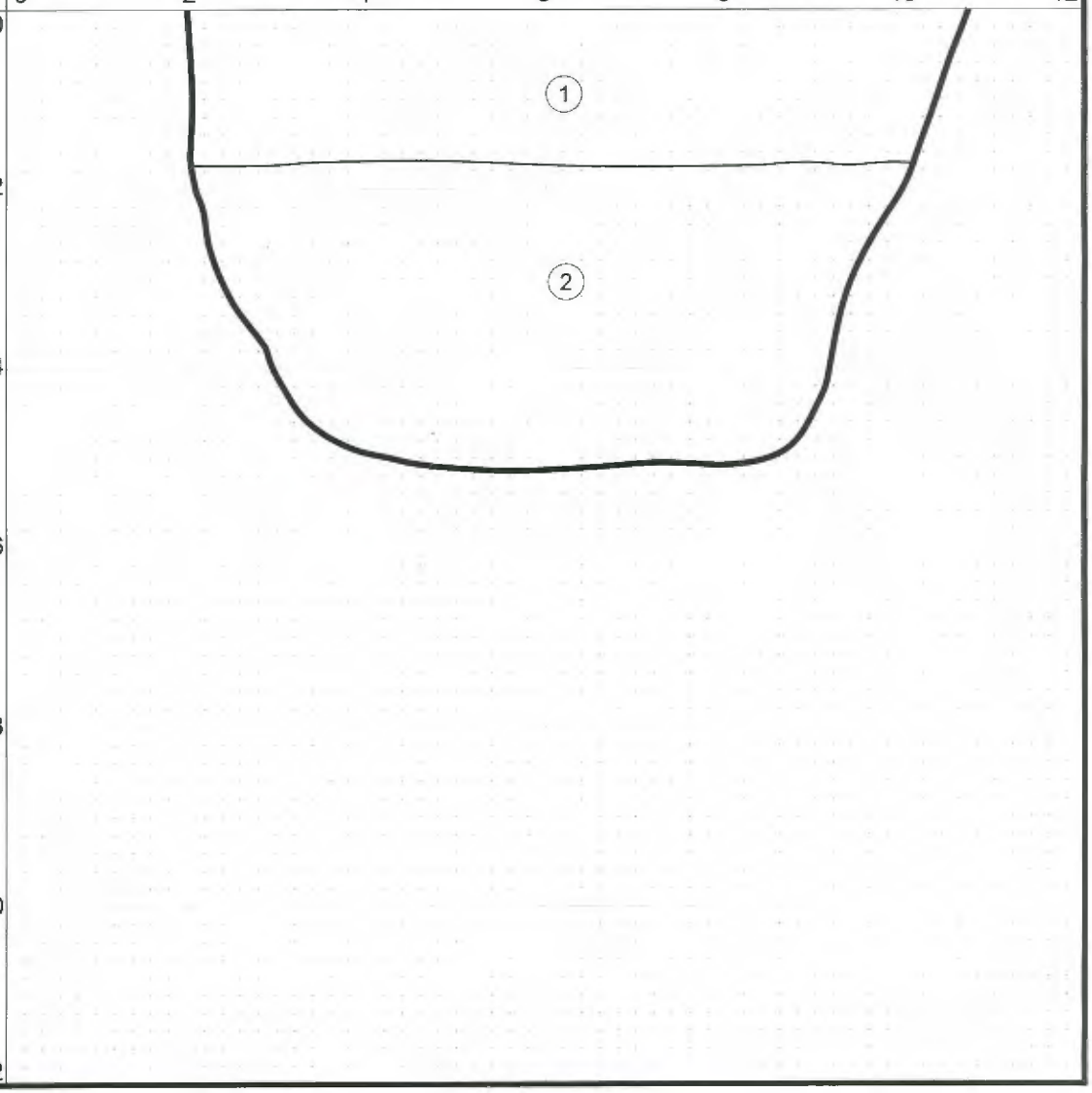
JOB NO: 101258-001 DATE: 8-8-2018 LOCATION: Bus Loop Extension

PROJECT: Tukwila Elementary School, Renovations and Modulars

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
1" Grass				0
(1) Soft to medium stiff, brown, *Silty Sand (SM)*; moist; few gravel. Fill or Reworked Earth (Hf).				
(2) Dense to very dense, brown, *Clayey Sand with Gravel (SC)*; moist; cobbles; low to medium plasticity fines. Till (Qvt)		11.3	S-1	2
Difficult to excavate.			S-2	4
Terminated at 5 feet.				6
				8
				10
				12

Sketch of Southwest Pit Side

Surface Elevation: Approx. 187.5 Ft.



NOTE

Dimensions: 2 feet x 8.7 feet. Excavated test pit to 3 feet to perform Pilot Infiltration Test. Overexcavated to 5 feet after the test was completed.

FIG. A-8

APPENDIX B: LABORATORY TEST RESULTS

Appendix B

Laboratory Test Results

CONTENTS

Tables

Tests

APPENDIX B: LABORATORY TEST RESULTS

We performed geotechnical laboratory testing on selected soil samples retrieved from the three test pits completed for the Tukwila Elementary School project. The laboratory testing program included tests to classify the soil and provide data for engineering studies. We performed visual classification on all retrieved samples. Our laboratory testing program included water content determinations, grain size distribution analyses, and Atterberg Limits determinations.

The following sections describe the laboratory test procedures.

B.1 VISUAL CLASSIFICATION

We visually classified soil samples retrieved from the borings using a system based on ASTM D2487-17, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System [USCS]), and ASTM D2488-09a, Standard Recommended Practice for Description of Soils (Visual-Manual Procedure). We summarize our classification system in Appendix A. We assigned a USCS group name and symbol based on our visual classification of particles finer than 76.2 millimeters (3 inches). We revised visual classifications using results of the index tests discussed below.

B.2 WATER CONTENT DETERMINATION

We tested the water content of selected samples in accordance with ASTM D2216-10, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. Comparison of the water content of a soil with its index properties can be useful in characterizing soil unit weight, consistency, compressibility, and strength. We present water content test results in the Laboratory Test Summary table in this appendix and on Appendix A exploration logs.

B.3 GRAIN SIZE DISTRIBUTION ANALYSIS

Grain size distribution analyses separate soil particles through mechanical or sedimentation processes. Grain size distributions are used to classify the granular component of soils and can correlate with soil properties, including frost susceptibility, permeability, shear strength, liquefaction potential, capillary action, and sensitivity to moisture. We plot grain size distribution analysis results in this appendix. Grain size distribution plots provide tabular information about each specimen, including USCS group symbol and group name, water content, constituent (i.e., cobble, gravel, sand, and fines) percentages, coefficients of uniformity and curvature, if applicable, personnel initials, ASTM standard designation, and

testing remarks. Constituent percentages are presented in the Lab Summary Table in this appendix.

B.3.1 Sieve Analysis

We performed mechanical sieve analyses on selected soil specimens to determine the grain size distribution of coarse-grained soil particles in accordance with ASTM C136/C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

B.4 ATTERBERG LIMITS DETERMINATION

We determined soil plasticity by performing Atterberg Limits tests on selected samples in accordance with ASTM D4318-10e1, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, Method A (Multi-Point Liquid Limit). The Atterberg Limits include liquid limit (LL), plastic limit (PL), and plasticity index (PI=LL-PL). These limits can assist soil classification, indicate soil consistency (when compared to natural water content), provide correlation to soil properties, evaluate clogging potential, and estimate liquefaction potential.

We present soil plasticity test results in the Lab Summary Table and on plasticity charts in this appendix. Plasticity charts provide the LL, PL, PI, USCS group symbol, the sample description, water content, and percent passing the No. 200 sieve (if a grain size distribution analysis was performed).

B.5 CONSIDERATIONS

Drilling and sampling methodologies may affect the outcome of prescribed geotechnical laboratory tests. Refer to the field exploration discussion in this report for a discussion of these potential effects. Instances of limited recovery may have resulted in test samples not meeting specified minimum mass requirements per ASTM standards. Test plots show which samples do not meet ASTM-specified minimum mass requirements.

B.6 REFERENCES

ASTM International, 2017, Standard practice for classification of soils for engineering purposes (unified soil classification system), D2487-17: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 12 p., available: www.astm.org.

ASTM International, 2010, Standard test methods for laboratory determination of water (moisture) content of soil and rock by mass, D2216-10: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 7 p., available: www.astm.org.

ASTM International, 2014, Standard test method for sieve analysis of fine and coarse aggregates, C136-14/C136M-14: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.02, concrete and aggregates, 5 p., available: www.astm.org.

ASTM International, 2010, Standard test methods for liquid limit, plastic limit, and plasticity index of soils, D4318-10e1: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 16 p., available: www.astm.org.

LABORATORY TERMS

Abbreviations, Symbols, and Terms	Descriptions
%	Percent
*	Sample specimen weight did not meet required minimum mass for the test method
"	Inch
#	Test not performed by Shannon & Wilson, Inc. laboratory
ASTM Std.	ASTM International Standard
C_c	Coefficient of curvature
Clay-size	Soil particles finer than 0.002 mm
cm	Centimeter
cm^2	Square centimeter
Coarse-grained	Soil particles coarser than 0.075 mm (cobble-, gravel- and sand-sized particles)
Cobbles	Soil particles finer than 305 mm and coarser than 76.2 mm
C_u	Coefficient of uniformity
CU	Consolidated-Undrained
ε	Axial strain
Fine-grained	Soil particles finer than 0.075 mm (silt- and clay-sized particles)
ft	Feet
γm	Wet unit weight
Gravel	Soil particles finer than 76.2 mm and coarser than 4.75 mm
G_s	Specific gravity of soil solids
H_o	Initial height
ΔH	Change in height
ΔH_{load}	End of load increment deformation
in	Inch
in^3	Cubic inch
LL	Liquid Limit
min	Minute
mm	Millimeter
μ_m	Micrometer
MC	Moisture content
MPa	Mega-Pascal
NP	Non-plastic
OC	Organic content
p	Total stress
p'	Effective stress
Pa	Pascal
pcf	Pounds per cubic foot
PI	Plasticity Index
PL	Plastic Limit
psf	Pounds per square foot
psi	Pounds per square inch
q	Deviatoric stress
Sand	Soil particles finer than 4.75 mm and coarser than 0.075 mm
sec	Second
Silt	Soil particles finer than 0.075 mm and coarser than 0.002 mm
t_n	Time to n% primary consolidation
t_{load}	Duration of load increment
tsf	Short tons per square foot
USCS	Unified Soil Classification System
UU	Unconsolidated-Undrained
WC	Water content

SAMPLE TYPES

Abbreviations, Symbols, and Terms	Descriptions
2SS	2.5-inch Outside Diameter Split-Spoon Sample
2ST	2-inch Outside Diameter Thin-Walled Tube
3HSA	3-inch CME Hollow-stem Auger Sampler
3SS	3-inch Outside Diameter Split-Spoon Sample
4SS	4-inch Inside Diameter Split-Spoon Sample
6SS	6-inch Inside Diameter Split-Spoon Sample
CA_MC	Modified California Sampler
CA_SPT	Standard Penetration Test (SPT)
CORE	Rock Core
DM	+3.25 inch Outside Diameter Split-Spoon Sample
DMR	3.25-inch Sampler with Internal Rings
GRAB	Grab Sample
GUS	3-inch Outside Diameter Gregory Undisturbed Sampler (GUS) Sample
OSTER	3-inch Outside Diameter Osterberg Sample
PITCHER	3-inch Outside Diameter Pitcher Sample
PMT	Pressuremeter Test (f=failed)
PO	Porter Penetration Test Sample
PT	2.5-inch Outside Diameter Thin-Walled Tube
ROCK	Rock Core Sample
SCORE	Soil Core (as in Sonic Core Borings)
SH1	1-inch Plastic Sheath
SH2	2-inch Plastic Sheath with Soil Recovery
SH3	2-inch Plastic Sheath with no Soil Recovery
SPT	2-inch Outside Diameter Split-Spoon Sample
SS	Split-Spoon
ST	3-inch Outside Diameter Thin-Walled Tube
STW	3-inch Outside Diameter Thin-Walled Tube
TEST	Sample Test Interval
TW	Thin Wall Sample
UNDIST	Undisturbed Sample
VANE	Vane Shear
WATER	Water Sample for Probe Logs
XCORE	Core Sample

LABORATORY TEST SUMMARY

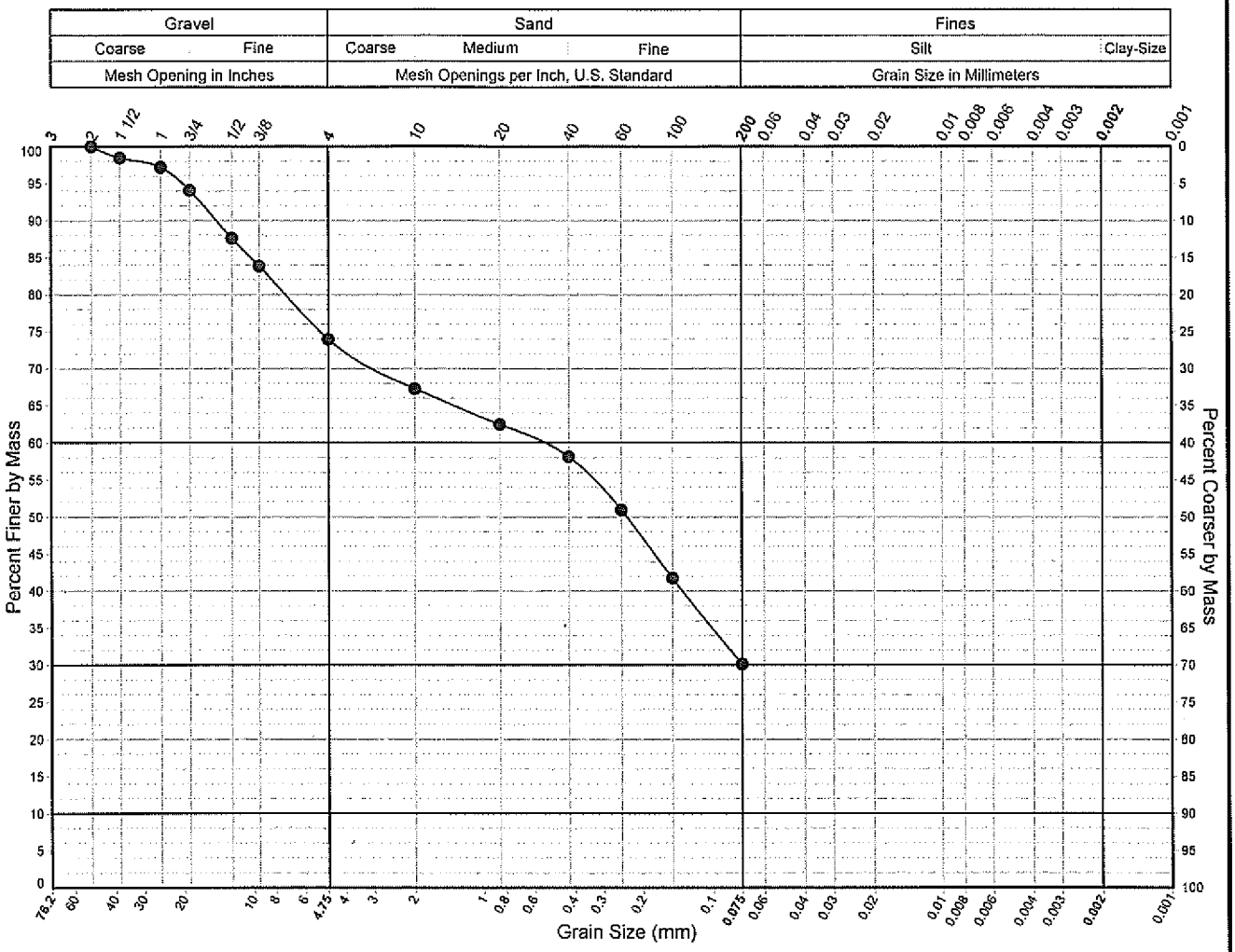
Boring	Top Depth (ft)	Sample Number	Sample Type	USCS	WC (%)	% Gravel	% Sand	% Fines	LL	PL	Soil Description
PIT-1	3	S-1	GRAB	SC	11.3	26*	44*	30*			Clayey Sand with Gravel
TP-4	4	S-1	GRAB	SC	11.8	17*	51*	32*			Clayey Sand with Gravel
TP-5	4	S-1	GRAB	CH	46.3				71	18	Fat Clay

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

Tukwila Elementary School
Tukwila, Washington

TEST PIT PIT-1



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● PIT-1, S-1*	3.0	SC	Clayey Sand with Gravel	26	44	30			11.3	AKV	AKV	C136

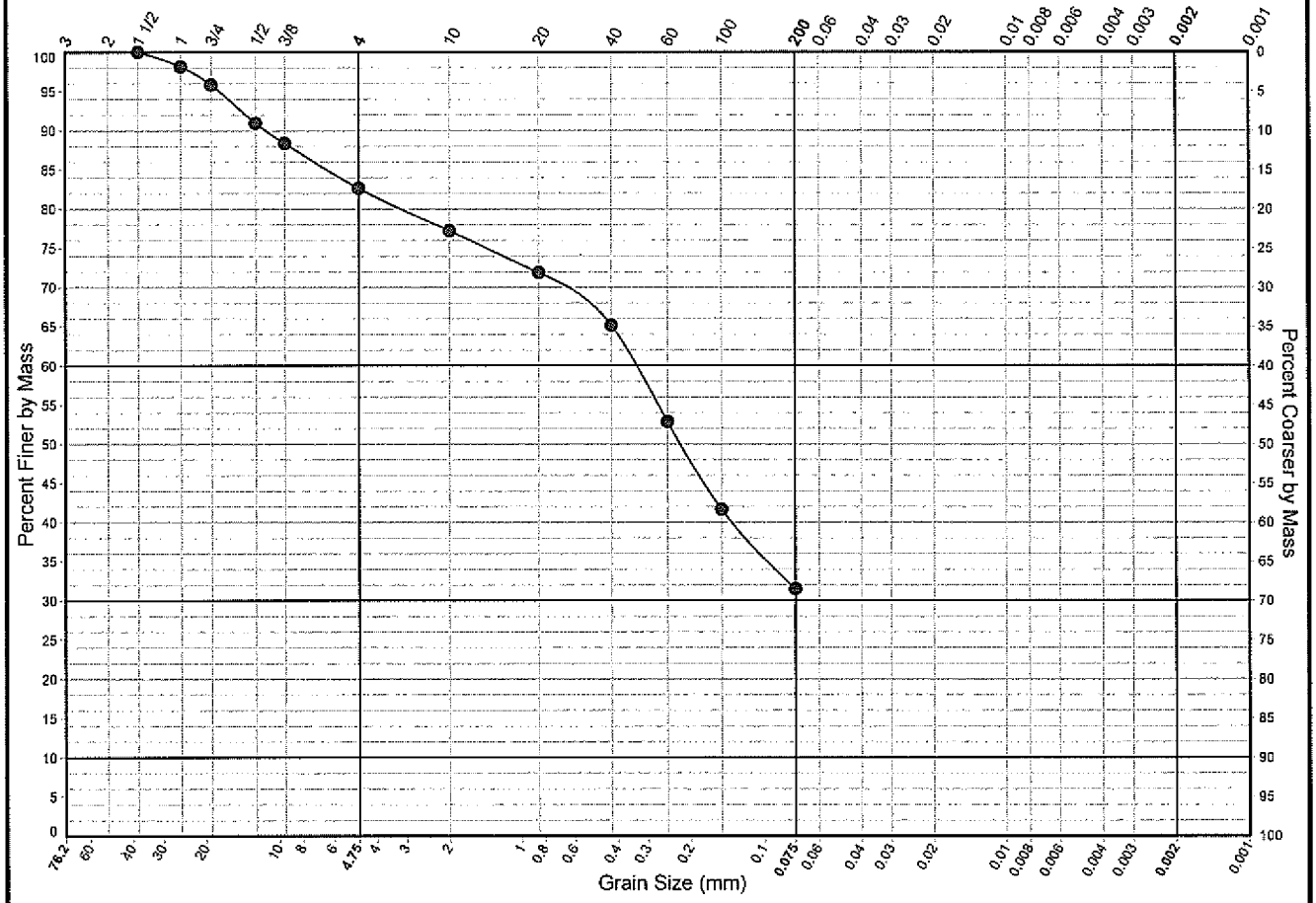
* *Test specimen did not meet minimum mass recommendations.*

SHANNON & WILSON, INC. GRAIN SIZE DISTRIBUTION PLOT

Tukwila Elementary School
Tukwila, Washington

TEST PIT TP-4

Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay-Size
Mesh Opening in Inches		Mesh Openings per Inch, U.S. Standard			Grain Size in Millimeters	



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● TP-4, S-1*	4.0	SC	Clayey Sand with Gravel	17	51	32			11.8	AKV	AKV	C136

** Test specimen did not meet minimum mass recommendations.*

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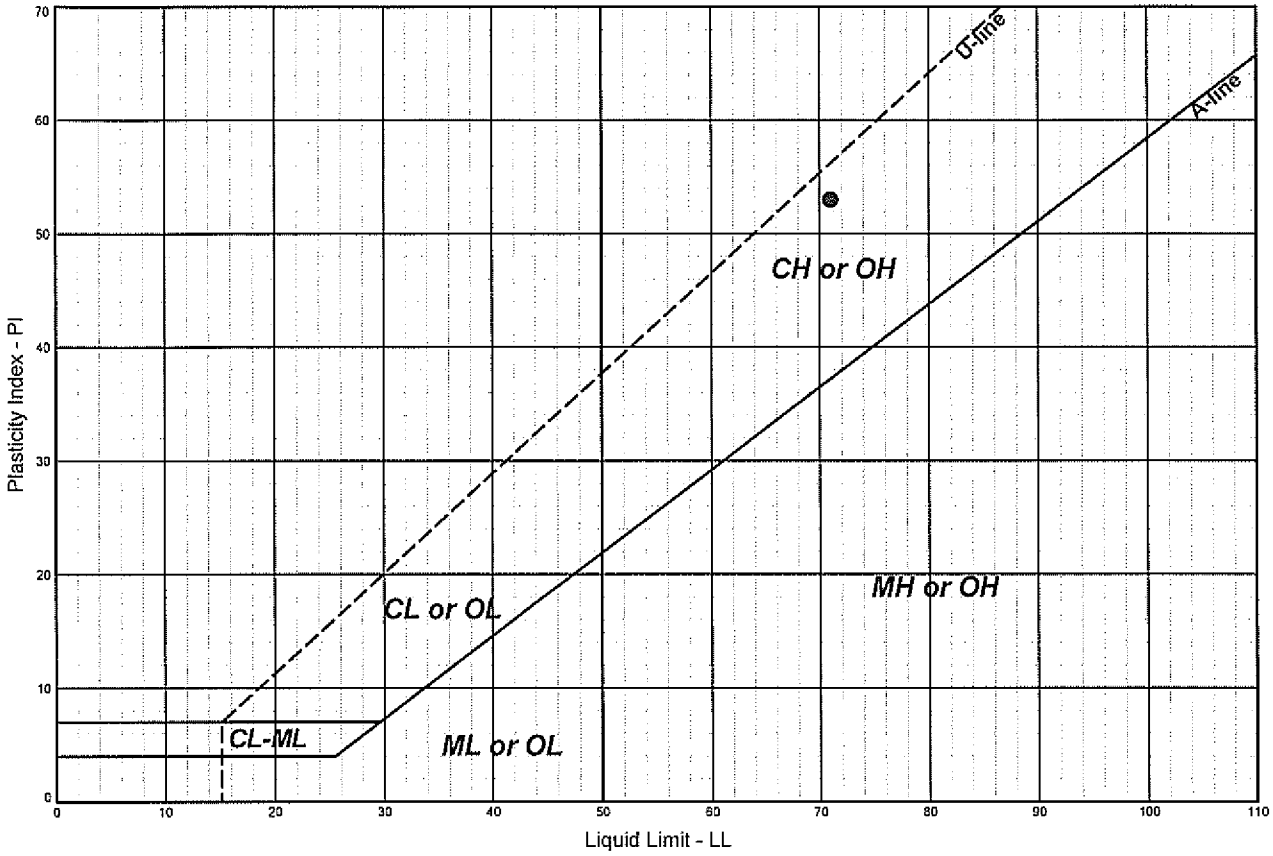
SHANNON & WILSON, INC.

PLASTICITY CHART

Tukwila Elementary School
Tukwila, Washington

TEST PIT TP-5



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	LL	PL	PI	WC %	Gravel %	Sand %	Fines %	< 2µm %	Tested By	Review By	ASTM Std.
● TP-5, S-1	4.0	CH	Fat Clay	71	18	53	46.3					AKV	AKV	D4318

101258-001 A_ATT_MAIN 101258.GPJ SHAN_WIL.GDT 8/21/18

IMPORTANT INFORMATION

Important Information

About Your Geotechnical Report

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent

IMPORTANT INFORMATION

such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

IMPORTANT INFORMATION

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland

Gilliam Creek Basin

Stormwater Management Plan

prepared for

City of Tukwila
Public Works Department

March 2001

Gilliam Creek Basin
Stormwater Management Plan

prepared for

City of Tukwila
Public Works Department
6300 Southcenter Boulevard
Tukwila, Washington 98188

prepared by

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 601
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Seattle, Washington 98154

March 9, 2001

Note:
Some pages in this document have been purposefully skipped or blank pages inserted so that this document will copy correctly when duplexed.

Contents

Tables

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Introduction

Gilliam Creek, located within the Green River drainage basin in King County, is one of the few natural stream systems in existence within the city of Tukwila. The Gilliam Creek channel has been fragmented by street crossings, urban development, and filling of wetlands. Currently, surface water runoff within the drainage basin is conveyed through a network of drainage ditches, open stream channels, and underground pipes that do not follow the historical tributary channels.

Although Gilliam Creek has been greatly altered by the impacts of urban development, it continues to provide important ecological, aesthetic, and practical functions. Realizing the importance of this stream system, the city of Tukwila has initiated a program to explore ways of improving water quality and fish habitat in Gilliam Creek.

This basin management plan includes the following elements:

- A description of existing conditions in the Gilliam Creek drainage basin with respect to stormwater runoff characteristics, water quality, and fish habitat
- A set of prioritized recommendations for improving conditions in the basin
- A discussion of alternative funding strategies for implementation of those improvements.

Much of the information contained in this document, with the exception of the final recommendations, was presented in preliminary form in an interim report, *Gilliam Creek Basin, Description of Existing Conditions and Alternatives for Improvement* (Herrera 2000). The recommendations contained in this report are based, in part, on review of that interim document by city of Tukwila staff and interested citizens.

Existing conditions within the basin were evaluated by Herrera Environmental Consultants based on review of previous studies and reports, a stream channel survey, field reconnaissance of the entire basin, collection and analysis of stormwater quality samples, and discussions with city of Tukwila personnel. As a result of an evaluation of potential capital improvement projects conducted by Herrera and RW Beck, recommended projects to improve water quality, flow control, and fish habitat in the basin are presented and prioritized. This basin management plan also addresses programmatic actions the city of Tukwila could take to enhance public awareness of Gilliam Creek and to promote pollution prevention in the basin.

Alternative funding options for the recommended capital improvement projects are discussed with respect to their applicability to the city of Tukwila and the Gilliam Creek drainage basin. The analysis of alternative funding options was prepared by RW Beck, based primarily on review of mechanisms used by other cities in the region.

Existing Conditions in the Gilliam Creek Basin

Drainage Basin Description

Gilliam Creek is located within the Green River drainage basin (water resource inventory area [WRIA] #09), and its confluence with the Green River occurs at river mile 12.7 (Williams et al. 1975, see Figure 1). The Gilliam Creek drainage basin (WRIA #09-0032) comprises approximately 1,835 acres, of which 1,535 acres lies within the city of Tukwila and the remaining 300 acres is in the city of SeaTac (Figure 2). The drainage basin is generally rectangular (averaging 1.25 miles wide and 2.25 miles long) with an east/west orientation. Elevations in the Gilliam Creek drainage basin range from 5 feet above mean sea level at the creek's confluence with the Green River to 175 feet above mean sea level at the crest of the McMicken Heights area in the southwest corner of the basin.

The historical Gilliam Creek channel has been fragmented by freeway and city street crossings, residential and commercial development, and filling of wetlands. Currently, surface water runoff within the drainage basin is conveyed through a network of underground pipes, drainage ditches, and open stream channels. The majority of this stormwater conveyance system consists of underground pipes that do not follow the historical tributary channels.

For the purpose of this study, the Gilliam Creek drainage basin has been divided into six subbasins (Figure 2), identified as Southcenter Mall, City Hall, I-5 East, I-5 West, Riverton Heights, and Crystal Springs. A description of each of these subbasins and its location is provided below.

Southcenter Mall Subbasin

This 200-acre subbasin drains much of the Southcenter Mall area into lower Gilliam Creek. This subbasin is bounded by Interstate 405 (I-405) to the north, Interstate 5 (I-5) to the west, the Green River to the east, and Strander Boulevard to the south. Most of this drainage is conveyed by stormwater pipes into lower Gilliam Creek, which drains into the Green River near the Tukwila Parkway crossing of I-405. This lower reach of Gilliam Creek conveys runoff from the entire drainage basin and is prone to frequent flooding, especially when the Green River water stage is high. Due to the heavily urbanized condition of this subbasin, peak runoff flow rates are high and the runoff from this area contains relatively high concentrations of a variety of pollutants. The Southcenter Mall subbasin corresponds to subbasins 20, 21, 22, and 24 as defined in the *Gilliam Creek Basin Drainage Study* (KCM 1986).

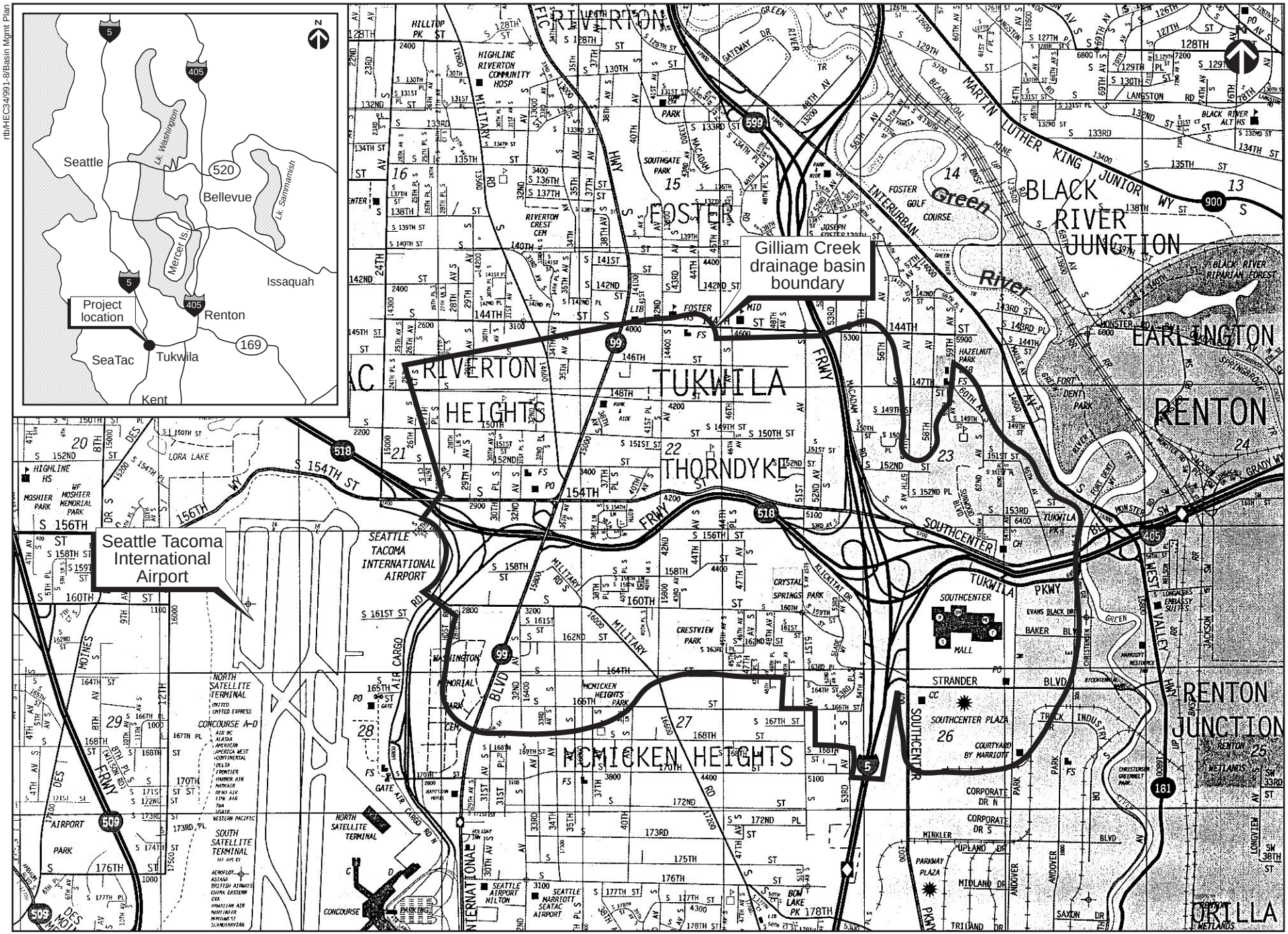

Figure 1. Vicinity of Gilliam Creek drainage basin, Tukwila, Washington.

rtb\HEC2\4991-9\Basin Mgmt Plan

Legend

- Major streets
- Open channel
- Piped flow
- Subbasin boundary
- Political boundary

0 960 feet
Approximate scale

N

24th Ave S
42nd Ave S
51st Ave S
60th Ave S
144th Street
154th Street
160th Street
166th Street
Military Road
Klickitat Drive
Southcenter Blvd
Green River

99
518
405
5
8

RIVERTON HEIGHTS SUBBASIN
I-5 WEST SUBBASIN
I-5 EAST SUBBASIN
CITY HALL SUBBASIN
CRYSTAL SPRINGS SUBBASIN
SOUTHCENTER SUBBASIN

North Tributary
Northwest Tributary
South Tributary
Southwest Tributary
ponds
wetland
wetland
WSDOT Ponds
ponds
Tukwila Pond

Tukwila City Limits
City of SeaTac

Seattle Tacoma International Airport
Southcenter Mall

HERRERA
ENVIRONMENTAL CONSULTANTS

Figure 2. Gilliam Creek basin characteristics.

City Hall Subbasin

This 136-acre subbasin extends north from I-405 to South 147th Street, and it is bounded on the east by the Green River and on the west by a ridge paralleling Sunwood Boulevard. The headwaters of this subbasin originate near the city of Tukwila Fire Station #52, and there is a small pond in the middle of the subbasin near South 151st Street. Drainage is generally conveyed in this subbasin through pipes, with the exception of open channels in the vicinity of the wetland and Tukwila city hall. Drainage from this subbasin is culverted underneath I-405 into lower Gilliam Creek. The City Hall subbasin corresponds to subbasins 1 and 2 in the *Gilliam Creek Basin Drainage Study* (KCM 1986).

I-5 East Subbasin

This 138-acre subbasin receives drainage from the western and southern slopes of a ridge paralleling Sunwood Boulevard and from the eastern shoulder of I-5. This subbasin extends north from I-405 to South 144th Street, and there is a large wetland near its headwaters. Drainage in this subbasin is generally conveyed through pipes and is culverted underneath I-405 into lower Gilliam Creek. The I-5 East subbasin corresponds to subbasins 3, 4, and 5 in the *Gilliam Creek Basin Drainage Study* (KCM 1986).

I-5 West Subbasin

The I-5 West subbasin is situated between the western shoulder of I-5 and 46th Avenue South, and it is bounded on the south by State Route (SR) 518 and on the north by South 144th Street. This 117-acre subbasin has its headwaters near Thorndyke School, and it receives drainage from the eastern slope of a ridge paralleling 46th Avenue South. Drainage is generally conveyed in open channels and ditches in this subbasin, but flow is piped at the downstream end prior to discharge into the pipe carrying the Gilliam Creek main stem flow. Drainage from the I-5 West subbasin enters the main drain line just upstream of the I-5/I-405 interchange. The I-5 West subbasin corresponds to subbasin 7 in the 1986 *Gilliam Creek Basin Drainage Study* (KCM 1986).

Riverton Heights Subbasin

This 1,002-acre subbasin is the largest of the six subbasins, encompassing 55 percent of the land area of the Gilliam Creek drainage basin. This subbasin is bounded on the west by 24th Avenue South and Seattle–Tacoma International Airport, and on the east by a ridge paralleling 46th Avenue South. The subbasin is bounded to the north by South 144th Street and to the south by a ridge (McMicken Heights). Drainage from this subbasin is conveyed in storm drains to four tributary channels that combine to form upper Gilliam Creek near SR 518. The headwaters of these four tributaries (north, northwest, southwest, and south) are described below.

The north tributary starts near the intersection of SR-99 and South 144th Street. The northwest tributary originates near the intersection of South 148th Street and 26th Avenue South. The southwest tributary begins near the intersection of SR-99 and South 166th Street in the city of SeaTac. The south tributary originates from ground water seeps on a slope near South 156th Street. Upper Gilliam Creek drains east, paralleling the north shoulder of SR 518; the drainage is then culverted under the I-5/I-405 interchange into lower Gilliam Creek.

The Riverton Heights subbasin corresponds to subbasins 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17 in the *Gilliam Creek Basin Drainage Study* (KCM 1986). Portions of this subbasin are heavily developed, particularly near the Tukwila International Boulevard corridor. Consequently, peak runoff rates are rapid and the pollutant content in runoff from those areas is relatively high.

Crystal Springs Subbasin

This 242-acre subbasin receives most of its drainage from ground water seeps on the northeast slope of McMicken Heights. This drainage is culverted underneath I-5 to a drainage ditch that is located between Southcenter Parkway and I-5. This subbasin is bounded on the north by SR 518, on the south and west by the ridge crest of McMicken Heights, and on the east by Southcenter Mall. The Crystal Springs subbasin corresponds to subbasins 18 and 19 in the *Gilliam Creek Basin Drainage Study* (KCM 1986).

Water Quality Conditions

Gilliam Creek has not been given a specific water quality designation by the Washington Department of Ecology (Ecology). The water quality designation for the stream is therefore determined by its receiving water, the Green River. The Green River is designated as Class A, indicating good overall water quality. Ecology lists the Green River as water quality-impaired with respect to the following parameters: metals, ammonia, fecal coliform bacteria, pH, low dissolved oxygen and high biochemical oxygen demand, and elevated temperatures. There is an abundance of water quality data available for the Green River but very little for Gilliam Creek. Previously collected water quality data are summarized in Table 1 and discussed below.

Previous Water Quality Sampling Data

A base flow sample was collected by Adolfson Associates, Inc. in June 1995 from the southwest tributary of Gilliam Creek, upstream of the 42nd Avenue crossing (Adolfson 1995). A duplicate sample was analyzed for pH, temperature, dissolved oxygen, dissolved metals, total petroleum hydrocarbons, and pesticides. All parameters were found to meet the Washington state Class A water quality criteria except pH, which was slightly lower than the criterion of 6.5. Pesticides and total petroleum hydrocarbons, for which no state criteria have been established, were not detected in these samples. The sample collection location used by Adolfson is identified in Figure 3.

Table 1. Historical Gilliam Creek water quality data.

Date	Location	pH	Temp (°C)	Hardness (mg/L)	DO (mg/L)	BOD_5 (mg/ L)	Dissolved Cd (mg/L)	Dissolved Cu (mg/L)	Dissolved Pb (mg/L)	Dissolved Zn (mg/L)	TPH (mg/L)	FOG (mg/L)	TP (mg/L)	NH_3 (mg/L)	NO_3+NO_2 (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fecal Coliform (#/100mL)	Pesticides
	Class A Criteria:	6.5-8.5	<18			>6	varies w/ hardness	varies w/ hardness	varies w/ hardness	varies w/ hardness							5 over bkgd	mean <100, >90% of samples <200	
6/15/95	42nd Ave crossing	*6.22*	11		9.7		<0.0002	<0.002	<0.001	0.022	<1.0								ND
6/15/95	(Duplicate)	*6.33*	11		8.9		<0.0002	<0.002	<0.001	0.015	<1.0								ND
9/11/97	158th St (upstream-base flow)	6.76	17.5	44.7	*4.5*	28.5		*0.0184*	0.0022	0.012	1.4	1.4	1.52	0.012	0.025	15	21	*est. 1840*	
9/11/97	(Duplicate)	6.79		44.7		28.2		*0.0182*	0.0026	0.016	1.2	1.3	1.53	0.034	0.041	14	20	*est. 140*	
9/11/97	158th St (downstream-base flow)	*6.4*	14	57.4	*3.2*	2.56		0.0019	0.0051	*0.128*	<0.25	<1.0	0.145	0.136	0.07	14	36	*440*	
9/11/97	(Duplicate)	*6.38*		57.1		2.56		0.0021	0.0052	*0.119*	<0.25	<1.0	0.378	0.133	0.064	58	58	<2	
10/30/97	158th St (upstream-storm)	6.73	12.7	9.38	9.5	<2.00		*0.0053*	0.002	*0.04*	<0.25	<1.0	0.062	0.043	0.124	3.6	6.6	*460*	
10/30/97	(Duplicate)	6.82		10.5		<2.00		*0.0068*	0.0032	*0.072*	<0.25	<1.0	0.06	0.036	0.127	3.6	6.8	*520*	
10/30/97	158th St (downstream-storm)	6.52	12.8	11.2	9.3	<2.00		*0.0068*	0.0062	*0.05*	<0.25	<1.0	0.058	<0.010	0.117	7.2	7.6	*est. 360*	
10/30/97	(Duplicate)	6.51		11.6		<2.00		*0.0082*	0.0089	*0.078*	<0.25	<1.0	0.058	0.012	0.119	6.8	7.7	*est. 320*	
1/5/99	158th St (upstream-base flow)	7.4	8.5	60.1	14.5	2.88		0.0053	<0.001	0.027	0.33	0.46	0.096	0.395	0.242	2.8	4.5	*4200*	
1/5/99	(Duplicate)	7.28	8.5	62.7	14.8	2.26		0.0054	0.0015	0.029	0.28	0.4	0.162	0.366	0.274	2.8	8.5	*est. 3800*	
1/5/99	158th St (downstream-base flow)	6.76	6.9	48.4	9.6	<2.00		0.004	*0.0014*	*0.077*	<0.25	<0.25	0.025	0.111	0.232	2	5.5	est. 8	
1/5/99	(Duplicate)	6.73	6.9	48.6	9.2	<2.00		0.0045	0.0011	*0.062*	<0.25	<0.25	0.025	0.107	0.232	0.5	4.2	est. 2	
1/14/99	158th St (upstream-storm)	6.88	8.9	11.3	12.5	<2.00		*0.0032*	<0.001	*0.032*	1	1.2	0.128	0.077	0.154	36	25	*480*	
1/14/99	(Duplicate)	6.74	9.2	13.9	10.2	<2.00		*0.0028*	<0.001	0.021	1.4	1.7	0.171	0.069	0.168	28	23	*est. 260*	
1/14/99	158th St (downstream-storm)	6.66	8.9	13.7	11.5	<2.00		0.0026	0.001	*0.025*	0.58	0.69	0.063	0.05	0.157	21	18	*est. 220*	
1/14/99	(Duplicate)	6.64	9	12.7	11.8	<2.00		0.0024	0.001	*0.022*	0.71	0.89	0.08	0.056	0.144	29	23	*262*	

Does not meet Class A water quality criteria

DO	dissolved oxygen	Pb	lead	NO_3+NO_2	nitrate+nitrite	mL	milliliters
BOD_5	5-day biochemical oxygen demand	TPH	total petroleum hydrocarbons	TSS	total suspended solids	NTU	nephelometric turbidity units
Cd	cadmium	FOG	fats, oils, and grease	Pest	pesticides		
Cu	copper	TP	total phosphorus	ND	Not detected (detection limits vary)		
Zn	zinc	NH_3	ammonia	mg/L	milligrams per liter		

Shapiro & Associates, Inc. collected storm and base flow samples from two locations on the southwest tributary of Gilliam Creek, immediately south of SR 518 on the eastern side of SR-99 (Shapiro 1997, 1999). The two stations sampled were upstream and downstream from a parking lot stormwater discharge point. Storm samples were collected in October 1997 and January 1999, and base flow samples were collected in September 1997 and January 1999. Duplicate samples were collected at both stations for all events. Samples were analyzed for pH, temperature, hardness, dissolved oxygen, 5-day biochemical oxygen demand, dissolved metals, total petroleum hydrocarbons, fats, oil, and grease (FOG), total phosphorus, ammonia, nitrate+nitrite, total suspended solids, turbidity, and fecal coliform bacteria.

In the base flow samples, parameters that did not meet Washington state Class A water quality criteria were pH, dissolved oxygen, dissolved copper, dissolved lead, dissolved zinc, and fecal coliform bacteria. In the storm samples, parameters that did not meet the water quality criteria were dissolved copper, dissolved zinc, and fecal coliform bacteria. Total petroleum hydrocarbons, fats/oil/grease, total phosphorus, ammonia, nitrate+nitrite, total suspended solids, and turbidity were detected in base flow and storm samples. While Washington state has not established water quality criteria for total phosphorus, ammonia, or total suspended solids, reported values for these parameters and turbidity were found to exceed the median levels and in some cases the maximum levels reported in Seattle area streams (Table 2). Sample collection locations used by Shapiro & Associates are identified in Figure 3.

Table 2. Water quality values found in Seattle area streams compared to Class A water quality criteria.

	Class A Water Quality Criteria	Storm Flow[a]			Base Flow[b]		
		Mean	Minimum	Maximum	Median	Minimum	Maximum
Temperature (^{o}C)	<18	–	–	–	10.6	8.0	13.5
pH	6.5–8.5	–	–	–	7.5	6.9	8.2
Dissolved oxygen (mg/L)	>6	–	–	–	10.4	5.8	11.4
Conductivity (µmhos/cm)		–	–	–	130	53	30,900
Hardness (mg/L as $CaCO_3$)		47.8	19.8	90.0	–	–	–
Turbidity (NTU)	<5 over bkgd	11	0.3	272	1.8	0.7	17
Total suspended solids (mg/L)		24	1.2	1,092	3.4	1.6	13
Total phosphorus (mg/L)		0.121	0.006	0.985	0.048	0.013	0.150
Ammonia nitrogen (mg/L)		0.037	0.010	1.700	0.015	< 0.005	0.190
Nitrate+nitrite nitrogen (mg/L)		0.638	0.160	1.900	0.630	0.07373	3.000
Copper (mg/L)	Varies w/hardness	0.005	< 0.001	0.014	–	–	–
Lead (mg/L)	Varies w/hardness	0.002	< 0.001	0.007	–	–	–
Zinc (mg/L)	Varies w/hardness	0.019	< 0.004	0.068	–	–	–
Fecal coliform bacteria (No./100 mL)	Geometric mean <100, less than 10% of samples >200	1,992	2	14,700	100	7	900

[a] Storm flow statistics are based on eight grab samples collected from 23 stream stations in the metropolitan Seattle area; mean values are geometric means (Metro 1994).
[b] Base flow statistics are based on 23 monthly grab samples collected from 50 stream stations in the metropolitan Seattle area (Metro 1994).

mg/L milligrams per liter
µmhos/cm micromhos per centimeter
$CaCO_3$ calcium carbonate
NTU nephelometric turbidity units
No./100 mL number of colonies per 100 milliliters.

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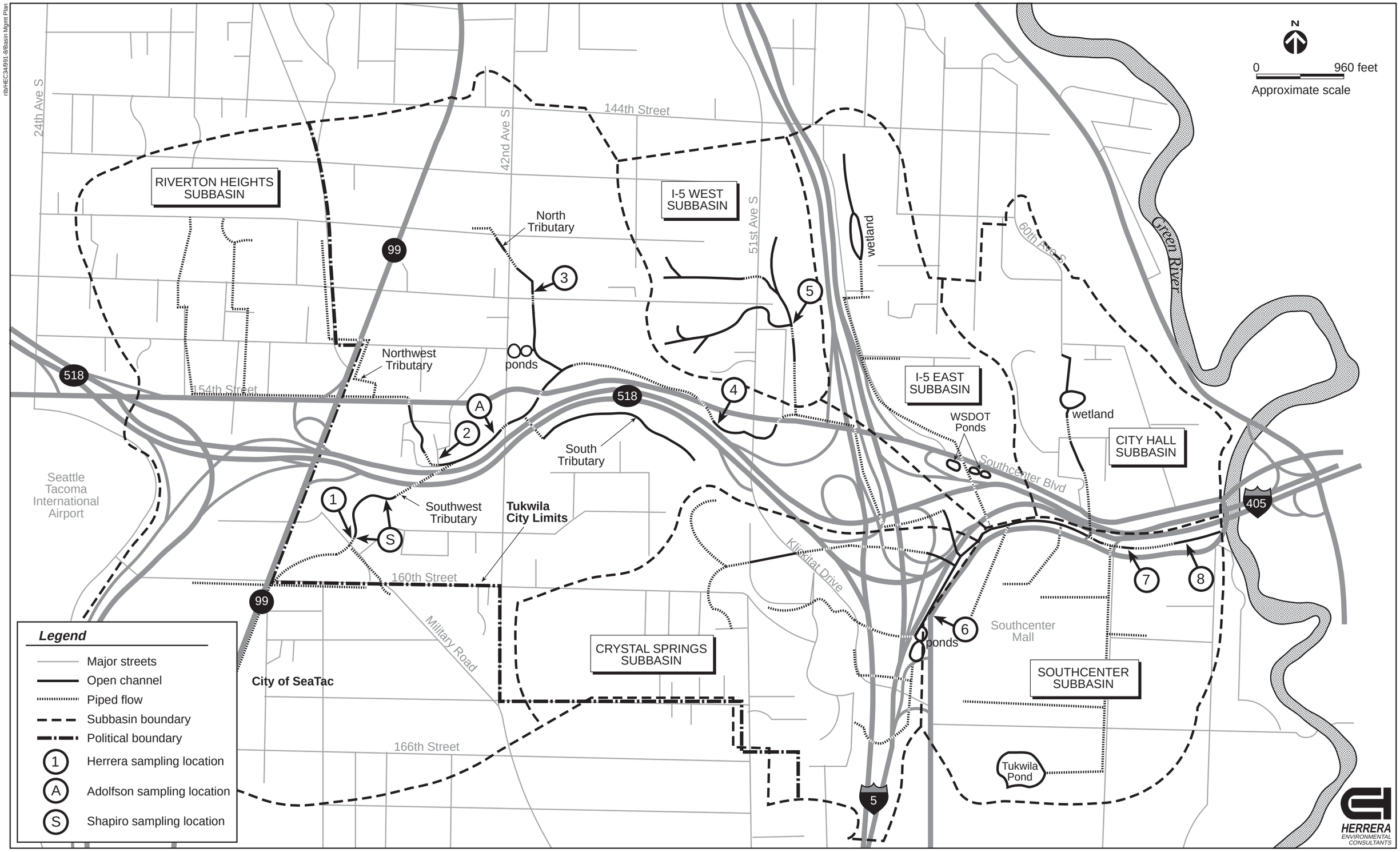

Figure 3. Gilliam Creek water quality monitoring stations.

Current Water Quality Sampling Data

Additional water quality samples were collected for the present study at eight locations within the Gilliam Creek basin. The purpose of this sampling effort was to identify the specific portions of the basin that are the greatest contributors to water quality degradation. At each of the eight sites, single grab samples of runoff from three storm events were collected and analyzed for total suspended solids, fecal coliform bacteria, dissolved metals (copper, lead, and zinc), and hardness. Temperature, pH, conductivity, dissolved oxygen, turbidity, and stream discharge were measured using field instruments. Field measurements and laboratory analytical results for the water quality samples are summarized in Table 3. Sample collection stations are identified in Figure 3.

Fecal coliform bacteria concentrations exceeded the Class A water quality criterion (geometric mean of 100 colony-forming units [CFU] per 100 milliliters [mL]) in all but two samples collected. Consistently higher fecal coliform levels were seen at sampling stations 2, 3, 4, 7, and 8. Water quality samples at several of the stations exceeded the Class A criterion for dissolved copper, which varies with hardness of the sampled water. Samples at stations 1 and 2 exceeded this criterion for all three storm events, while samples from stations 3, 4, 6, and 8 exceeded the criterion during one event. Dissolved lead was not detected in any of the water quality samples. Dissolved zinc was present at levels above the Class A criterion (which varies with hardness) at station 1 for all three sampling events and at station 2 for one event. Temperature, pH, and dissolved oxygen results were within Class A criteria for all samples except at station 1. In the first storm event sampled at station 1, the pH level was slightly lower than the minimum Class A criterion.

Turbidity and total suspended solids levels were elevated in water quality samples at all Gilliam Creek basin locations. While there is a Class A water quality criterion for turbidity, it is defined as 5 nephelometric turbidity units (NTU) above the background level, and no background value has been developed for the sampling stations used in the present study. Turbidity and total suspended solids levels therefore have been evaluated in relation to mean values found in Seattle-area urban streams during storm flow (Metro 1994). The mean turbidity value reported by Metro (1994) was 11 NTU. Turbidity levels in all samples collected during the first two storm events exceeded this mean value. Turbidity levels during the third storm event were lower, exceeding 11 NTU in samples from five of the eight stations. Total suspended solids levels exceeded the mean value reported by Metro (24 mg/L) in more than half of the samples collected from the first two storm events. Only one sample during the third storm event exceeded this mean value (station 2). Consistently higher turbidity and total suspended solids values were seen at stations 1, 2, and 4, while station 6 had consistently lower values.

Stream discharge rates account for some of the variations in water quality results between storm events and between stations during a single storm event. The timing of the recent sample collection effort with respect to the storm runoff hydrograph led to this variation in discharge rates. The flow measurements obtained at the various sampling stations occurred over a period of several hours and in that time the runoff may have changed from the rising limb of the hydrograph to the falling limb (i.e., before peak to after peak). This variation is most evident at station 4 during the first storm event and at stations 7 and 8 during the second event.

Table 3. Gilliam Creek water quality sampling results compared to Class A water quality criteria.

Sample Location	Sample Date	Discharge (cfs)	Temperature (deg C)	pH	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Hardness (mg/L)	TSS (mg/L)	Fecal Coliform (#/100mL)	Dissolved Cu (mg/L)	Dissolved Pb (mg/L)	Dissolved Zn (mg/L)
Class A Criteria			<18	6.5–8.5		>6	5 over bkgd			mean <100, >90% of samples <200	varies w/ hardness	varies w/ hardness	varies w/ hardness
Storm 1													
Gilliam 1	10/27/99	1.6	10.4	6.80	72.3	12.9	27.9	23.3	61	*700*	*0.0136*	<0.0010	*0.102*
Gilliam 2	10/27/99	2.4	9.8	6.86	42.5	13.4	46.6	23.5	58	*1280*	*0.008*	<0.0010	*0.037*
Gilliam 3	10/27/99	0.5	10.0	7.27	61.4	12.9	53.5	23.1	44	*420*	*0.0068*	<0.0010	0.004
Gilliam 4	10/27/99	14.8	9.7	7.17	70.6	12.7	88.4	27.4	168	*5800*	*0.0067*	<0.0010	0.017
Gilliam 5	10/27/99	0.4	8.5	7.04	234.0	10.5	33.0	93.2	37	*180*	0.0042	<0.0010	0.009
Gilliam 6	10/27/99	1.4	10.5	7.66	181.8	13.0	21.4	70.9	19	*2400*	*0.0087*	<0.0010	0.018
Gilliam 7	10/27/99	6.1	10.3	7.47	136.7	12.1	23.2	52.8	20	*3200*	0.0057	<0.0010	0.011
Gilliam 8	10/27/99	6.7	10.2	7.38	103.1	12.9	31.4	42.0	31	*6400*	*0.0062*	<0.0010	0.014
Storm 2													
Gilliam 1	11/5/99	2.8	9.4	6.78	54.3	13.5	51.1	16.4	62	*780*	*0.0088*	<0.0010	*0.033*
Gilliam 2	11/5/99	0.6	10.1	7.00	66.5	13.0	30.0	29.3	18	*6200*	*0.0054*	<0.0010	0.018
Gilliam 3	11/5/99	0.1	9.6	7.38	123.9	12.6	17.4	52.2	13	*5600*	0.0029	<0.0010	<0.003
Gilliam 4	11/5/99	5.3	9.7	7.38	118.1	13.8	29.8	52.4	31	*3600*	0.0045	<0.0010	0.01
Gilliam 5	11/5/99	0.3	8.2	6.94	222.0	10.3	32.9	93.4	32	88	0.0028	<0.0010	0.007
Gilliam 6	11/5/99	3.2	9.9	7.45	128.0	14.0	19.7	55.3	16	76	0.0049	<0.0010	0.006
Gilliam 7	11/5/99	21.6	9.9	7.30	91.0	14.1	18.9	37.7	25	*124*	0.0048	<0.0010	0.009
Gilliam 8	11/5/99	36.0	9.9	7.20	69.3	14.1	25.7	27.4	33	*920*	*0.004*	<0.0010	0.009
Storm 3													
Gilliam 1	11/19/99	1.2	10.2	*6.39*	55.0	10.5	27.0	18.4	20	*720*	*0.0076*	<0.0010	*0.031*
Gilliam 2	11/19/99	0.9	10.4	6.59	66.0	10.4	24.0	23.6	34	*4800*	*0.0048*	<0.0010	0.016
Gilliam 3	11/19/99	0.4	11.0	7.00	198.1	9.4	7.8	79.2	19	*1100*	0.0011	<0.0010	<0.003
Gilliam 4	11/19/99	4.1	10.2	7.24	160.9	10.7	22.0	67.0	30	*980*	0.0031	<0.0010	0.007
Gilliam 5	11/19/99	0.3	9.4	6.83	244.0	8.6	7.7	103.0	7.2	*300*	0.0013	<0.0010	0.008
Gilliam 6	11/19/99	0.8	10.8	7.34	218.0	10.3	9.9	94.4	8.3	*500*	0.0029	<0.0010	0.006
Gilliam 7	11/19/99	10.8	10.2	7.24	168.0	10.2	17.0	68.2	20	*960*	0.0029	<0.0010	0.008
Gilliam 8	11/19/99	9.0	10.6	7.14	168.0	9.9	17.0	69.4	17	*660*	0.0023	<0.0010	0.009

Does not meet Class A water quality criteria

cfs	cubic feet per second	mg/L	milligrams per liter NH	mL	milliliters
(µmhos/cm)	micromhos per centimeter	NTU	nephelometric turbidity units		

The results of the recent monitoring effort provide a good starting point for understanding the water quality characteristics and problems of Gilliam Creek. Sample results indicate that the Gilliam Creek tributaries conveying stormwater from the highly developed areas along SR-99 (represented by sampling stations 1 and 2) are experiencing the greatest water quality degradation. These conditions are less apparent in the lower reaches of the basin, but the highly developed commercial areas around Southcenter Mall are likely contributing similarly high levels of stormwater pollutants. Dense residential development in other portions of the drainage basin is also partially responsible for the degraded water quality in Gilliam Creek.

Drainage Conditions

Most of the Gilliam Creek drainage basin consists of highly developed urban land uses, including single- and multifamily residential areas, commercial and office areas, and roadway surfaces. These types of urban land uses are characterized by large areas of impervious surfaces associated with roads, parking lots, sidewalks, and rooftops. Impervious surfaces convey rainfall to receiving waters much more quickly than do pervious land areas such as undeveloped forest and open space, causing increased peak flows and runoff volumes. This is evident in Gilliam Creek, where scour and erosion characterize the upper reaches of the stream, resulting in sediment deposition and flooding in the lower reaches. These problems of upstream erosion and downstream sedimentation are exacerbated by the topography of the basin, which has relatively steep stream channel slopes in the upper basin and a flat channel gradient in the lower basin.

The Gilliam Creek basin has few large stormwater detention facilities capable of reducing peak flows in the stream. A two-cell stormwater detention and treatment pond located at South 152nd Street and 42nd Avenue South discharges to the north tributary of Gilliam Creek. Several ponds located in the I-5 East and City Hall subbasins, while not designed as detention ponds, may provide some amount of flow control. Undersized culverts and pipe inlets at two locations in the main stem of Gilliam Creek also provide some degree of incidental flow control as stream water backs up in these areas during large storm events. These undersized inlets are the 42nd Avenue South culvert and the pipe inlet just downstream of the confluence with the north tributary of Gilliam Creek (KCM 1993).

In recent years, development projects have been required to incorporate stormwater detention facilities in their drainage systems in order to comply with city of Tukwila code requirements. In 1995, through ordinance 1755 (Tukwila Municipal Code chapter 14.30), Tukwila adopted the design criteria set forth in the 1990 King County *Surface Water Design Manual* to guide drainage design at development sites throughout the city. This section of the municipal code also adopts subsequent amendments to the King County manual; consequently, the 1998 update to the King County manual is now being applied to drainage design throughout Tukwila. The city of SeaTac also has up-to-date stormwater management requirements in effect, having adopted the 1998 revision of the King County *Surface Water Design Manual* (SeaTac Municipal Code chapter 12.10). As a result, individual development sites are achieving peak flow reduction in many areas of the basin.

Although these small detention systems provide improvements in comparison to areas without any flow control, the net effect on peak flows in Gilliam Creek is collectively minor. The creek continues to suffer from excessive peak flows generated throughout the basin. In recent years, since both cities enacted formal stormwater management requirements, no large projects incorporating stormwater controls on a regional scale have been developed. Consequently, major reductions in peak flows from substantial portions of the drainage basin have not been realized.

Fish Habitat Conditions

Fish habitat within the Gilliam Creek watershed is restricted to open-channel segments in the lower reach downstream of I-5. This lower reach, totaling 2,900 feet in length in the Southcenter Mall and Crystal Springs subbasins, has been fragmented by urban development. Fish have not been found in any of the remaining segments of open channel within the watershed. Degraded water quality and high flows in the creek have significantly altered the natural channel habitat that once existed. Fish species occurrence and habitat conditions in Gilliam Creek are described below.

Fish Species Presence

Anadromous fish species reported to occur in lower Gilliam Creek include chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and sea-run cutthroat trout (*O. clarki clarki*) (Partee 1999 personal communication). Other anadromous fish that may occur in lower Gilliam Creek include Pacific lamprey (*Entosphenus tridentatus*) and river lamprey (*Lampetra ayresi*) (Wydoski and Whitney 1979).

Resident fish species expected to occur in Gilliam Creek include cutthroat trout *(O. clarki)*, western brook lamprey (*L. richardsoni*), and sculpin (*Cottus* sp.). Resident fish species that may occur in Gilliam Creek, based on their geographic distribution and habitat requirements, include longnose dace (*Rhinichthys cataractae*), speckled dace (*R. osculus*), largescale sucker (*Catostomus macrocheilus*), and three-spine stickleback (*Gasterosteus aculeatus*) (Wydoski and Whitney 1979).

Anadromous and Resident Fish Habitat

The only reach of Gilliam Creek that is accessible to anadromous fish is located along the south shoulder of I-405 between the Green River and I-5. This is also the only reach in which resident fish have been observed. This reach alternates between open channels and culverted segments that extend from the confluence with the Green River to the eastern edge of the I-5 right-of-way. Access to this reach is restricted by a large flap gate at the outlet of a culvert where Gilliam Creek drains into the Green River. This flap gate controls flows in a 9-foot-diameter culvert underneath Tukwila Parkway, just upstream of I-405. Fish can pass upstream through this flap gate only when the Green River water stage is high (but lower than the Gilliam Creek stage) and when there is sufficient discharge from Gilliam Creek to force the flap gate open enough for fish passage. The occurrence of these conditions is limited; consequently, anadromous fish access to the lower reach of Gilliam Creek is far from optimal.

Potential salmon spawning and rearing habitat in the lower reach of Gilliam Creek consists of four segments of open channel separated by four corrugated metal pipe culverts. The culverted sections include a 9-foot-diameter culvert under Tukwila Parkway, a 9-foot-diameter culvert under the south shoulder of I-405, a 78-inch-diameter culvert under an on-ramp to I-405, and a 72-inch-diameter culvert under the overpass between Southcenter Boulevard and Tukwila Parkway. None of these culverts presents a migration barrier to returning adults, but during high discharge the culverts may act as barriers to juvenile fish.

Available fish habitat in the lower three segments of open channel in this reach is characterized by a straight channel confined by steep banks. The dominant habitat types include low-gradient riffles, dammed pools, lateral scour pools, and runs. The wetted channel width averages 12 feet, the average depth in riffles is 6 inches, and the average depth of pools is 2 feet. Substrate in the stream channel is dominated by sand and silt in pools, and gravel and cobbles in riffles. The available spawning gravels are embedded with 20 percent fines. Riparian vegetation on both banks consists of mature deciduous forest dominated by black cottonwood (*Populus balsamifera*) and red alder (*Alnus rubra*) in the tree layer, while the shrub layer is dominated by Himalayan blackberry (*Rubus discolor*), Indian plum (*Oemleria cerasiformis*), snowberry (*Symphoricarpos albus*), and salmonberry (*Rubus spectabilis*). There is a moderate amount of large woody debris that forms lateral scour pools. Spawning habitat is limited by the lack of gravels and silt embeddedness, while juvenile rearing habitat is limited by the lack of off-channel refuge and cover typically provided by undercut banks, riparian vegetation, and channel diversity.

Available fish habitat in the upper segment of open channel in this reach, between the I-5/I-405 interchange and a culvert beneath the overpass connecting Tukwila Parkway and Southcenter Boulevard, is characterized by a narrow meandering channel, unconfined banks, and a wide floodplain. The dominant habitat types in this segment are low-gradient riffles, runs, and lateral scour pools. The average wetted width is 10 feet, the average depth of riffles is 3 inches, and the average depth of pools is 1 foot. Substrate in the streambed is dominated by sand and silt, with lesser amounts of small gravel. The floodplain benches on both banks are vegetated by Sitka willow (*Salix sitchensis*), reed canarygrass (*Phalaris arundinacea*), small-fruited bulrush (*Scirpus microcarpus*), horsetail (*Equisetum* sp.), and common cattail (*Typha latifolia*). Riparian vegetation higher on the banks consists of black cottonwood, red alder, Himalayan blackberry, and salmonberry. Spawning habitat is limited by the lack of gravels and silt embeddedness, while juvenile rearing habitat is limited by the shallow pool depth and lack of large woody debris.

Summary of Existing Problems

As described in the previous sections, a variety of water quality, flooding, and habitat problems are evident in the Gilliam Creek basin, ranging from basin-wide problems to site-specific issues. Appendix B summarizes the problems identified in this study and in previous studies that have not yet been rectified, along with potential improvement projects associated with these problems. The following section discusses capital improvement projects and programmatic actions that are recommended for the Gilliam Creek basin.

Recommended Capital Improvement Projects and Programmatic Actions

This section presents a summary of capital improvement projects that are recommended to address drainage, water quality, and habitat problems in the Gilliam Creek basin. A prioritization scheme is introduced and applied to the recommended projects. Finally, a discussion is provided on additional programmatic actions (i.e., actions other than capital improvements) that are recommended for enhanced protection of Gilliam Creek and downstream waters.

Recommended Improvement Projects

A number of potential capital improvement projects were developed and analyzed during the course of this study. This section discusses those projects that are recommended for inclusion in the city of Tukwila capital improvement program. A summary of all of the potential capital improvement projects that were analyzed, along with an explanation of the potential projects that were dropped from consideration, is provided in Appendix B.

Some of the recommended improvement projects have been identified in previous documents and are revisited here. Others were developed as a part of this study. All improvement projects were analyzed to determine feasibility and potential benefit to the Gilliam Creek system. Cost estimates were also developed for the recommended improvement projects. Project summaries in the form of fact sheets are included in Appendix C, along with supporting technical analysis data for the recommended projects.

Table 4 summarizes the recommended capital improvement projects, including estimated costs and priority designation. Geographical locations of the recommended improvement projects are displayed in Figure 4.

Prioritization of Improvement Recommendations

The recommended improvement projects listed in Table 4 are described in an interim report entitled *Gilliam Creek Basin, Description of Existing Conditions and Alternatives for Improvement* (Herrera, 2000). City of Tukwila staff and interested citizens were given the opportunity to review the potential improvements and provide comments on preferred projects. Based on these comments and additional analysis of environmental benefits and costs, priority rankings were applied to the proposed improvement projects to guide future implementation.

Table 4. Recommended capital improvement projects for the Gilliam Creek basin.

Project	Location	Proposed Capital Improvement	Estimated Cost	Relative Priority (4–18)
D1	Gilliam Creek outlet to Green River	Construct 250-cfs (cubic feet per second) pump station with fish passage facilities.	$3,200,000 (includes 15-cfs pump station in D6)	7
D2	Between 40th Ave S and 42nd Ave S	Construct in-stream ponds and biofiltration swale.	$300,000	12
D3	Andover Park W	Replace undersized pipe.	$370,000	9
D4	North of S 154th St and east of 42nd Ave S	Construct regional in-stream detention pond.	$220,000	17
D5	Strander Blvd near Andover Park E	Replace undersized pipe.	$215,000	7
D6	James Christensen Rd	Construct 15-cfs pump station with fish passage facilities.	See D1	7
D9	54th Ave S between Slade Way and S 166th St	Upgrade existing ditch and construct detention facility.	$905,000	7
D10	S 146th St from Military Rd S to SR-99	Replace undersized pipe.	$320,000	7
D16	Intersection of 42nd Ave S and S 146th St	Construct detention or detention/treatment ponds.	$266,000	12
D19	52nd Ave S and S 154th St	Construct detention/ treatment pond	$598,000	9
D20	South side of S 154th St, near SR-99	Construct biofiltration swale.	$57,000 (does not include land purchase/easement costs)	8
D22	Near intersection of Old Military Rd and S 158th St	Construct regional detention pond.	$730,000	12
D23	SR-99 between S. 146th St and S. 152nd St	Construct underground detention tanks.	$159,000 per site; up to 6 sites	10
D24	SR-99 between S 146th St and S 152nd St	Construct underground water quality treatment vaults.	$80,000 per site; up to 6 sites	11
H1	Section of north tributary between 150th St S and 152nd St S	Reinforce channel bed and bank. Construct log check dams in channel, and place riprap on weak bank sections.	$475,000	10
H2	Outlet of Gilliam Creek to Green River	Construct fish ladder leading to existing flap gate, and replace flap gate with self-regulating tide gate.	$650,000	14
H3	Along Tukwila Parkway between I-5 culvert and outfall to Green River	Implement channel modifications to improve habitat. Widen stream channel, install large woody debris and riparian vegetation, and increase sinuosity where appropriate.	$294,000[a]	11
H4	Southwest corner of 42nd Ave S and S 48th St	Plant riparian vegetation.	$5,500	10
H5	South of S 154th St near 52nd Ave S intersection	Plant riparian vegetation.	$17,000	10
H6	Along Tukwila Parkway west of 61st Ave S between I-5/I-405 ramp and Southcenter Parkway	Construct pond at confluence of main stem and tributary for fish habitat enhancement, water quality treatment, and flood storage.	$131,000	11

Notes:
See Table 5 for listing of projects in order of relative priority
a This cost applies to modifications to all open channel segments in lower Gilliam creek.
The cost to modify individual segments would be generally proportional. See Appendix C.

rtb\HEC24\991-9\Basin Mgmt Plan

N

0 960 feet

Approximate scale

24th Ave S

144th Street

42nd Ave S

51st Ave S

60th Ave S

Green River

RIVERTON HEIGHTS SUBBASIN

I-5 WEST SUBBASIN

CITY HALL SUBBASIN

I-5 EAST SUBBASIN

SOUTHCENTER SUBBASIN

CRYSTAL SPRINGS SUBBASIN

D10

D16

D23

D24

99

H4

North Tributary

wetland

H1

D4

ponds

D19

518

154th Street

Northwest Tributary

D20

D2

South Tributary

H5

WSDOT Ponds

wetland

Southcenter Blvd

H2

H3

405

Seattle Tacoma International Airport

Southwest Tributary

Tukwila City Limits

D22

160th Street

Klickitat Drive

H6

D3

D1

Southcenter Mall

ponds

D6

Military Road

City of SeaTac

D9

D5

166th Street

Tukwila Pond

5

HERRERA ENVIRONMENTAL CONSULTANTS

Legend

- Major streets
- Open channel
- Piped flow
- Subbasin boundary
- Political boundary
- D1 Recommended improvement project location

Figure 4. Gilliam Creek basin recommended drainage, water quality, and habitat improvement project locations.

Priority Level Determination

Priority rankings assigned to the proposed Gilliam Creek drainage basin improvements were based on four criteria: 1) city of Tukwila comments; 2) potential ease of permitting; 3) environmental benefit; and 4) cost effectiveness. A range of numerical values was applied to each category, and the scores in all four categories were summed to produce an overall prioritization score.

City of Tukwila Comments

City of Tukwila staff comments were solicited after copies of the interim report were distributed. Citizen comments were solicited through a public meeting at which the proposed improvements were presented. This public meeting, conducted at Tukwila city hall on March 29, 2000, was attended by only three Tukwila residents. While comments and concerns were communicated by city staff regarding the proposed projects, there was very little citizen input.

Based on city staff comments, a score of 1 to 5 was applied to each recommended project. A low score (1) was applied to projects the city deemed useful but not of near-term importance. A high score (5) was applied to projects the city is clearly interested in implementing in the near future. An intermediate score (3) was applied to projects for which no indication was given.

Potential Ease of Permitting

Potential ease of permitting was considered for each recommended project, based on the project's likely impact upon fish-bearing streams, wetlands, and steep slopes, as well as the associated implications for involvement by several regulatory agencies.

A score of 1 to 3 was applied to each project for ease of permitting. A low value (1) was applied to projects for which permits are required from multiple agencies, where this could cause significant delays in project implementation. An intermediate value (2) was applied to projects for which permits are required from agencies outside the city, where this would not be expected to delay or complicate the project significantly. A high value (3) was applied to projects for which the only permits required are those administered by the city.

Environmental Benefit

The determination of environmental benefit for each project is based, where applicable, on the amount of watershed runoff that would be treated or detained. The rating of environmental benefit for habitat projects is based on improvement of fish usage of Gilliam Creek.

A score of 1 to 5 was applied to each project for environmental benefit. A low score (1) was applied to projects that would result in very little improvement in peak flow reduction, water quality, or fish habitat in Gilliam Creek. A high score (5) was applied to projects that would result in a significant improvement to any of these three objectives. Intermediate scores (2

through 4) were applied to various projects based on the relative degree of environmental improvement that could be accomplished, short of significant improvement.

Cost Effectiveness

Cost effectiveness was determined for each project based on the estimated cost relative to the expected environmental benefit. A score of 1 to 5 was applied to each project for cost effectiveness. A low score (1) was applied to costly projects that would provide minimal environmental benefit to Gilliam Creek. A high score (5) was applied to relatively inexpensive projects that would provide a significant benefit. Intermediate values (2 through 4) were applied to relatively inexpensive projects that would provide moderate benefits, and to costly projects that would provide greater benefits.

Overall Priority Ranking

To determine the overall priority level for each recommended improvement project, a total score was calculated from the individual criteria. The lowest possible score was 4 and the highest possible score was 18; a project scoring intermediate values for each category would have a total score of 11. Table 5 shows the priority scoring values of the recommended improvement projects listed in descending order, from the highest to the lowest priority projects.

Programmatic Actions to Enhance Protection of Gilliam Creek

In addition to the variety of capital improvements that could be undertaken to improve water quality, flooding, and habitat conditions in Gilliam Creek, the city should consider several programmatic actions for enhanced protection of Gilliam Creek. The following paragraphs briefly describe these actions.

Pollution Source Control Program for Targeted Businesses

As discussed in the existing conditions section of this report, runoff originating in and near the SR-99 corridor contributes extensively to downstream problems in Gilliam Creek. This portion of the basin contains numerous businesses that do not have stormwater control systems on their sites, and that are not likely taking proactive steps to minimize stormwater pollution on their sites. Some of the newer businesses may have stormwater treatment and detention systems on their sites as a result of the city's adoption of stormwater management requirements in recent years, but older businesses almost certainly do not. Some of these businesses may be required to implement pollution prevention measures under the state's National Pollutant Discharge Elimination System (NPDES) permit program (certain classifications of industrial sites have been targeted for permit coverage). However, many other businesses are not required to take action under existing regulations. It is unlikely that runoff conditions will improve in the near future at a given business site unless the site is significantly redeveloped, thereby invoking requirements to retrofit stormwater treatment and detention facilities in accordance with current city standards.

Table 5. Priority level determination for recommended Gilliam Creek improvement projects.

Project	Proposed Improvement	City of Tukwila Comments (1–5)	Potential Ease of Permitting (1–3)	Environmental Benefit (1–5)	Cost Effectiveness (1–5)	Total Score (4–18)
D4	Construct regional in-stream detention pond	5	2	5	5	17
H2	Construct fish ladder and replace flap gate at outfall	5	1	5	3	14
D2	Construct in-stream ponds and biofiltration swale	3	2	4	3	12
D16	Construct detention or detention/treatment ponds	3	3	3	3	12
D22	Construct regional detention pond	1	2	5	4	12[b]
D24	Construct underground water quality treatment vaults	1	3	4	3	11
H3	Implement channel modifications to improve habitat	1	2	4	4	11
H6	Construct pond for fish habitat, treatment, and flood storage	1	2	4	4	11
D23	Construct underground detention tanks	1	3	4	2	10
H1	Reinforce channel bed and bank	3	2	3	2	10
H4	Plant riparian vegetation	1	3	2	4	10
H5	Plant riparian vegetation	1	3	2	4	10
D3	Replace undersized pipe	3	3	1	2	9
D19	Construct detention/treatment pond	1	3	3	2	9[a]
D20	Construct biofiltration swale	1	3	2	2	8
D1	Construct 250 cfs pump station	3	1	2	1	7
D5	Replace undersized pipe	1	3	1	2	7
D6	Construct 15 cfs pump station	3	2	1	1	7
D9	Upgrade existing ditch and construct detention facility	1	3	2	1	7
D10	Replace undersized pipe	1	3	1	2	7

[a] This project was given a low priority despite its higher score due to the possibility of property development at this location.
[b] This project was given a low priority despite its higher score due to planned property development at this location.

The city should inventory the businesses in the SR-99 corridor, prioritize those that present the greatest potential for adverse stormwater problems, and work with those targeted businesses to achieve meaningful improvements. Much of this effort would focus on identification and implementation of source control best management practices (BMPs) that are tailored to the business activity and site conditions. Examples of source control BMPs include employee education regarding pollution prevention and waste minimization, frequent cleaning and maintenance of waste storage and disposal areas, frequent sweeping of parking lots, providing covers or containment devices for waste storage and disposal areas, and relocating activities that pollute stormwater runoff under cover. Several jurisdictions in western Washington have

developed source control BMP manuals that could serve as references. The city's coordinated efforts with targeted businesses would require conducting a meeting with representatives of each business, assisting the business with development of effective BMPs, and conducting follow-up visits to the business site as necessary to ensure that the BMPs are being implemented and to help troubleshoot implementation problems.

This type of partnering with businesses to achieve pollution reduction could also be applied in other areas of the Gilliam Creek basin, particularly in the Southcenter area. Because the Southcenter area drains to the lower reach of Gilliam Creek, where the benefits of reduced pollution in stormwater runoff would have less effect on the creek due to the short distance to the outlet at the Green River, this area should be targeted after the SR-99 corridor has been addressed. Improvements in stormwater quality in the Southcenter area would also benefit the Green River downstream of the Gilliam Creek outlet.

BMP Handbooks

In combination with the business partnering effort described above, the city should develop a handbook summarizing BMPs that can be applied in various situations to improve stormwater quality. The handbook could identify various types of source control and treatment BMPs, provide examples of business practices and site conditions where they would apply, and offer recommendations on cost-effective ways to implement them. A further step in this effort should be development of a BMP handbook for residences, focusing on BMPs applicable to gardening and lawn care, automobile washing and maintenance, painting and refinishing activities, and waste storage and disposal.

Public Notice of Updates on Basin Plan Implementation

The Hazelnut offers a convenient means of informing residents and businesses in the city about stormwater-related problems in the Gilliam Creek basin, actions that are being taken to improve upon those problems, and the status of progress in improving conditions. A similar recommendation was provided in the basin plans for the Fostoria and Riverton Creek basins (Herrera 1996; Entranco et al. 1997), but *The Hazelnut* has yet to be used as a forum for discussion of these types of issues.

Locational Signage for Gilliam Creek and Its Tributaries

Signs along roadways offer a simple and effective means of educating the public about the presence of streams and the need for public stewardship of them. The city has already fabricated several signs indicating creek crossings, but not all of these have yet been posted. These signs should be posted as soon as possible in the Gilliam Creek basin (and elsewhere in Tukwila).

Storm Drain Stenciling

Another simple and cost-effective means of educating the public about the presence of streams and the effects of pollutants in stormwater runoff involves posting storm drain inlets with notices such as *DUMP NO WASTE; DRAINS TO GILLIAM CREEK*. A stencil is used to paint the pavement adjacent to the storm drain inlet. Although the city has promoted stenciling of storm drains in other areas through the use of volunteers and school groups, this effort has not focused attention in the Gilliam Creek basin. To enhance public awareness of pollution problems in Gilliam Creek, the city should promote similar storm drain stenciling efforts in the Gilliam Creek basin.

Increased City Staff Resources to Implement Programmatic Actions

Some of the previous recommendations for stormwater-related programs in Tukwila have not been carried out because of limited staff availability. The city should consider hiring additional staff in the Public Works Department to carry out the recommendations listed above, as well as similar recommendations listed in the *Fostoria Basin Stormwater Quality Management Plan* (Herrera 1996) and the *Riverton Creek Stormwater Quality Management Plan* (Entranco et al. 1997).

Funding Options Analysis

During development of the Gilliam Creek Stormwater Quality Management Plan, a review of the city of Tukwila stormwater utility funding sources was conducted. This was done, in part, because anticipated and new demands on the surface water utility, such as fulfilling the requirements of the federal Endangered Species Act and NPDES Phase II regulations, will require additional efforts in stormwater control to improve water quality and protect and restore fish habitat. This will likely increase the needs in all areas of stormwater management, including operation and maintenance, engineering, and capital improvements. In anticipation of these increased demands, consideration should be given to other sources of revenue for the stormwater program. The task of this financial element included a meeting with city staff to review the city's current methods for generating stormwater revenue and funding capital projects, as well as identifying other secondary funding source options and considering approaches used by other jurisdictions.

Current Stormwater Funding Program

Tukwila currently funds its stormwater program with a combination of utility service charges, state grants and loans, interlocal coordination, and permit fees. These funding sources are discussed separately below.

Stormwater Utility Revenue

The city's primary funding source for the existing stormwater program is a storm and surface water utility that was established in 1989 (Ordinance 1523). The revenues collected by the utility are used to fund the planning, construction, operation and maintenance, and improvement of the utility facilities, both natural and constructed. The revenues are also used to pay debt service on loans used for capital improvements.

The methodology for the original formation of the city's storm and surface water utility is described in Appendix K of the *City of Tukwila Surface Water Management Comprehensive Plan* (KCM 1993). While this document is dated 1993, most of the work of the utility formation was done prior to or during 1989. The storm and surface water utility is a stand-alone entity, set up as an enterprise fund, within the governmental structure. It is defined as being financially and organizationally self-sufficient, and is designed to furnish a comprehensive set of services related to management of surface water quantity and quality.

A utility rate and service charge is imposed on every property parcel within the city, including those owned by the city and the Washington State Department of Transportation. The service charge is based upon the contribution of surface water runoff to the system, as defined by the estimated percentage of developed surface area of the property. Developed surface area is defined as surfaces that have altered the natural infiltration or runoff patterns and increase

stormwater runoff. Developed single-family residential parcels are grouped together into one rate category and pay a specified service charge per parcel. The current categories and annual rates are given in Table 6.

Table 6. Stormwater utility year 2000 service rates.

Rate Category	Monthly Service Charge (per acre)	Monthly Service Charge (per parcel)
1. Natural	$ 0.54	–
2. 0 – 20% developed surface	$ 1.16	–
3. 21 – 50% developed surface	$ 2.13	–
4. 51 – 70% developed surface	$ 3.18	–
5. 71 – 85% developed surface	$ 3.83	–
6. 86 – 100% developed surface	$ 4.47	–
7. Single-family residential parcels	–	$4.33

The above rates were established in a 1999 rate increase. Even with the rate increase, the city's current rates are below the rates of many jurisdictions within the region. For comparison, Table 7 gives rates of other jurisdictions for single-family residential parcels.

Table 7. Comparison of area surface water utility service rates for a typical single-family residence (November 2000).

Location	Monthly Rate
Redmond	$11.50
Mercer Island	$10.35
Bellevue	$9.19
King County	$7.09
Burien	$7.09
Des Moines	$6.42
Seattle	$6.06
Olympia	$6.00
Bothell	$5.56
Auburn	$5.50
Mukilteo	$5.40
Renton	$5.23
Kirkland	$5.00
SeaTac	$5.00
Tukwila	$4.33
Edmonds	$3.70
Kent	$2.44

Grants and Loans

The city, where possible, uses grants or loans to supplement the storm and surface water utility revenues. The city has successfully obtained Public Works Trust Fund (PWTF) low-interest loans for capital improvements, as well as Washington Department of Ecology (Ecology) Centennial Clean Water Fund (CCWF) grants for basin water quality studies. Additional information on grant and loan programs is discussed later in this section.

Interlocal Coordination

Some of the drainage infrastructure within the city of Tukwila is actually owned and operated by others through an interlocal agreement. The city of Tukwila is a member of the Green River Basin Program and Interlocal Agreement (GRIA). Members of the Green River Basin Program signed an interlocal agreement dated June 30, 1992, which sets forth policies and regulations to coordinate Green River Basin Program activities. The members of the Green River Basin Program include King County and the cities of Tukwila, Auburn, Kent, and Renton. Activities of the basin program are funded by revenues generated by the Green River Flood Control Zone District. The activities are also coordinated with the U.S. Army Corps of Engineers. The GRIA sets guidelines for future pumped discharges into the Green River and levee improvements; assigns interior drainage responsibilities; and provides technical leadership, public safety, and welfare through a levee monitoring system, emergency operations, a flood warning system, and cost sharing. This program funds the operation and maintenance of the P-17 stormwater pump station in the city of Tukwila.

This program is also identified as a funding source for the Duwamish riverbank stabilization projects identified in the city's current capital improvement plan.

Permit Fees

The city collects permit fees for new development and redevelopment proposals. These permit fees cover some of the time spent by engineering staff to review stormwater plans. However, according to city staff, the fee collected does not usually cover the actual cost of the reviews.

Summary

In general, the priority for the city's stormwater utility revenue (projected at approximately $2.1 million in 2000) is to fund stormwater operations and maintenance, debt service, and engineering. After these program activities are funded, the remaining revenue is available for constructing capital improvements.

As noted previously, new and pending federal regulations are likely to result in increased demands on the stormwater utility. The following section discusses several options for secondary sources of revenue.

Secondary Funding Options

State and Federal Grants and Loans

A number of state and federal programs offer grants or loans for qualifying projects (usually capital improvements). These grants and loans should be sought out as a secondary funding source. It is important to note that competition for funding is vigorous, and successful acquisition of this funding cannot be ensured.

The Flood Control Assistance Account Program

The Flood Control Assistance Account Program (FCAAP), administered by Ecology, assists local jurisdictions in comprehensive planning and maintenance efforts to reduce flood hazards and flood damages. To be eligible for grant funding, flood hazard management activities must be approved by Ecology and the Washington Department of Fish and Wildlife (WDFW). In addition, local jurisdictions must participate in the National Flood Insurance Program (NFIP).

Grants are available for the following activities:

- Comprehensive flood hazard management plans (including surface water management plans and stormwater management plans) (up to 75 percent funding)
- Flood damage reduction projects and studies control management projects (up to 50 percent funding)
- Emergency flood control projects (up to 80 percent funding)
- Flood warning systems (up to 75 percent funding)
- Bioengineered bank stabilization projects (up to 50 percent funding)
- Public awareness programs (up to 75 percent funding).

A total appropriation of $4 million is made to the flood control assistance account for each fiscal biennium (July 1 of odd-numbered years). Of this appropriation, up to $500,000 may be allocated to any one county, including all jurisdictions within that county.

Washington Department of Ecology's Water Quality Financial Assistance

Ecology's water quality program administers three major funding programs that provide grants and low-interest loans for projects that protect and improve water quality in Washington state. Ecology acts in partnership with state agencies, local governments, and Indian tribes by providing financial and administrative support for their water quality management efforts. To the extent possible, Ecology manages the three programs as one; there is one funding cycle, application, and offer list for the following programs:

- The Centennial Clean Water Fund (CCWF) provides grants and low-interest loans to construct wastewater treatment facilities and funds activities to reduce nonpoint sources of water pollution.
- The State Revolving Loan Fund (SRF) provides low-interest loans to construct wastewater treatment facilities and related activities, or to reduce nonpoint sources of water pollution.
- The Section 319 Nonpoint Source Grants Program (Section 319) provides grants to reduce nonpoint sources of water pollution.

These programs fund the following types of project:

- Planning, design, and construction of wastewater and stormwater treatment facilities
- Combined sewer overflow reduction
- Stream and salmon habitat restoration
- Local loan funds to repair or replace onsite sewer systems or implement agricultural best management practices
- Water reuse planning and facilities
- Watershed planning
- Water quality monitoring
- Lake restoration efforts that focus on pollution prevention
- Wellhead protection
- Acquiring wetland habitat for preservation
- Construction of public boat pump-outs
- Public information and education.

Grant and low-interest loan combinations may be available for up to 100 percent of eligible project costs. Grants for constructing point source facilities are available for up to 50 percent of eligible project costs. Grants for nonpoint source activities are available for up to 75 percent of eligible project costs. Grants for non-site-specific planning (such as comprehensive sewer and stormwater planning or watershed planning) are available for 75 percent of eligible project costs. Loans may be used to provide the grant match.

Loans are available for up to 100 percent of eligible project costs. On private property, only loans may be obtained for site-specific facilities planning and design, land acquisition,

installation of collection sewers and side sewers, and implementation projects (e.g., best management practices for landowners).

Through the Centennial Clean Water Fund, Ecology anticipates that $11.7 million will be available in competitive grants and loans for point source and nonpoint source projects in fiscal year 2001. The state legislature has approved another $5 million in grants, the use of which is limited to facilities and projects located in small towns. Approximately $1.8 million more will be available as competitive grants for nonpoint source projects from Section 319 in fiscal year 2001. Subject to congressional action, Ecology expects to have approximately $62 million available from the State Revolving Loan Fund for low-interest loans in fiscal year 2001.

Public Works Trust Fund

The Public Works Trust Fund (PWTF), administered by the Washington Department of Community, Trade, and Economic Development, is a revolving loan fund that funds the "repair, replacement, rehabilitation, reconstruction or improvement of eligible public works systems to meet current standards for existing users and may include reasonable growth as part of this project." Projects designed to serve future growth are not eligible for PWTF funding. PWTF offers four loan programs:

- Construction program
- Pre-construction program
- Emergency loan program
- Public works planning loan program.

For construction loans, jurisdictions with populations less than 100,000 are eligible for up to $7 million per biennium. Loan terms of up to 20 years are available at rates that vary, depending upon the amount of local participation. Loans are at 1 percent interest for a 30 percent local match; 2 percent interest for a 20 percent local match; and 3 percent interest for a 10 percent local match. For pre-construction loans, up to $1 million per jurisdiction per biennium is available, with a 5-year repayment term that can be converted to a 20-year payback if construction funding is secured. Interest rates depend on the amount of the local match.

The Natural Resources Conservation Service (formerly the Soil Conservation Service)

The Natural Resources Conservation Service (NRCS) developed the *West Side Green River Watershed Work Plan* in the 1960s. This plan and subsequent updates recommended specific measures to manage surface water runoff and control flooding in the Tukwila/Auburn valley area east of the Green River. The P-17 pump station was funded under this program. Flood hazard reduction projects proposed in the valley portion of Tukwila may be eligible for funding if they are consistent with the NRCS plan. The NRCS is coordinating with the city of Renton, which is currently performing design work on the widening of Springbrook Creek.

The West Side Green River Watershed Project (WSGRWP) was declared inactive by NRCS in the 1980s during preparation of an update to the economic analysis performed by NRCS.

Reactivating the WSGRWP would require a local sponsor, such as the city of Tukwila, to coordinate with NRCS and update the economic analysis. The economic analysis would have to show a benefit/cost ratio meeting the program requirements.

The program funds $30 million per year nationwide, and numerous projects are already defined as eligible projects awaiting funding. Funding is very competitive, although the local NRCS office is supportive of local requests for funding.

U.S. Army Corps of Engineers

The Corps of Engineers Ecosystem Restoration Project may begin a nationwide program that would provide funding and other assistance for stream and river restoration. It may be possible to work with the Corps to obtain this funding or other assistance on applicable projects.

Federal Emergency Management Agency (FEMA)

The state of Washington administers hazard mitigation grants for jurisdictions affected by a federally declared disaster. The federal money is appropriated through FEMA and must be applied for following each event. The amount of the annual appropriation varies with the magnitude of the disaster(s). However, a jurisdiction in an affected county may apply for relief whether or not it was affected by the disaster in question. There is a specified time period following a disaster within which one may apply. It may be possible to apply for and receive hazard mitigation grants for projects designed to protect life and property where there have been prior disasters.

New Programs

Several new grant and loan programs to aid communities with salmon recovery are becoming available through the state of Washington. Many of these programs are about to begin, and most are intended for capital projects to remove fish barriers and provide additional habitat in fish-bearing streams. Some of these programs are listed below.

Salmon Recovery Funding Board

WDFW grant funding decisions are made by the agency's Salmon Recovery Funding Board (SRFB), a panel of experts concerned with getting the most benefit for the enhancement dollars. As a result, fisheries enhancement projects funded by WDFW grant monies involve different cost/benefit parameters than do projects funded through other sources. Grant funding for salmon enhancement projects has increased dramatically in the past two years, but so has the competition for such funding, and the bar is expected to rise even higher during the next funding cycle.

On December 8, 1999, WDFW concluded the comment period the need for predesign for salmon habitat projects. The SRFB's purpose in promoting predesign work is to sponsor more appropriate, better-developed, and more cost-effective enhancement projects. This will further

increase the quality of grant applications and make thorough and effective predesign analysis even more critical than it has been in the past. It is likely that only the most practical, well-developed projects with the highest margin of return related to fish enhancement will be funded. Therefore, maximizing fisheries benefits on a per-unit-cost basis must be a critical element in determining the feasibility of alternatives.

Washington Department of Natural Resources 2000 Aquatic Lands Enhancement Account

This grant program supports aquatic lands enhancement projects for the purchase, improvement, or protection of aquatic lands for public purposes; for providing and improving access to such lands; and for volunteer cooperative fish and game projects. Grant applications were accepted until May 1, 2000. If approved, the funding would become available July 1, 2001. This grant program is on a biannual budgeting cycle.

Washington State Fish Passage Grant Program

The state requested $12 million in May 1999 for projects to be funded in 2000. The program focuses on improving fish passage. (The contact is Cliff Hall, grant program manager, Washington Environmental Affairs Office, (360) 705-7499.)

Potential Secondary Funding Sources within the City of Tukwila

The following paragraphs describe other potential secondary funding sources that the city could establish, and modifications to funding sources that could be considered within the city's existing framework of fee collection.

Plan Review and Inspection Fees

According to city staff, permit fees presently collected do not cover the actual costs involved in reviewing the drainage aspects of development proposals and performing field inspections. These fees should be increased to directly cover the costs of those activities related to drainage review.

Capital Facilities/Connection Charges

Capital facilities charges (CFCs) are one-time charges assessed at the time of development or redevelopment to recover a proportionate share of a utility's capital investment, including the costs of both existing facilities and planned future facilities. The applicability of capital facilities charges depends on 1) how existing facilities were funded, and 2) the city's interpretation of state law regarding future facilities costs (legal opinions by other city attorneys have validated the inclusion of future facilities costs in the CFC calculation). Capital facilities charges, if applicable, would provide a revenue stream from new development or redevelopment (for developments not having previously paid the CFC) to be used for capital construction and related

costs. Because these are development-related fees, the stability of fee revenues depends upon growth occurring as anticipated.

Capital facilities charges, or connection charges, are charges imposed as conditions of service to recover an equitable share of capital investment incurred by a utility. The two basic elements of a capital facilities charge are the general facilities charge (GFC) and the system development charge (SDC). The GFC is based on the cost of existing facilities, while the SDC is based on the estimated costs of planned future capital improvements.

The intent of the general facilities charge is to provide an instrument for new development to buy into the cost borne by the ratepayers for existing facilities. Of the two components, the general facilities charge is most clearly and explicitly authorized in the applicable state statute (RCW 35.92.025). However, only those capital costs previously incurred by the stormwater utility ratepayers are appropriate for inclusion in the charge. The city's stormwater infrastructure has been built through a combination of developer contributions, general fund tax sources, and the utility fees since 1990. Developer-donated assets have had no impact on existing ratepayers, and the cost is not recoverable in the charge. Because the city charges for an undeveloped property, ratepayers have already paid for a share of the existing system through taxes and utility fees, and it is not equitable to require them to invest again. In short, it is most likely that the city has little or no basis for a general facilities charge.

The statute (RCW 35.92.025) does not explicitly allow or disallow a charge that includes future capital costs (i.e., the system development charge). While several cities have incorporated a system development charge, other cities have been reluctant to include the charge without specific authorization. It is recommended that the Tukwila city attorney investigate the question and write an opinion on the defensibility of system development charges. Many stormwater utilities in western Washington collect a system development charge.

It is also recommended that the city consider a capital facilities charge made up entirely of the system development charge component. The system development charge calculation is relatively straightforward the cost of facilities planned for construction over the study period is divided by the expected customer base at the end of the study period.

Local Improvement Districts or Other Assessment Districts

Most commonly structured as local improvement districts (LIDs), these funding mechanisms generally assess individual properties directly benefited or served by a specific capital improvement. These benefited properties share in the cost of that facility.

A local improvement district may be initiated by legislative action (by the applicable jurisdiction) or by petition, but ultimately requires the assent of benefited property owners for implementation. If it is initiated by petition, a simple majority of benefited property owners must sign the final petition. In either case (legislative action or petition), if property owners representing 60 percent of the amount to be assessed file protests, the local improvement district may not be formed.

Local improvement districts are an equitable way of recovering costs from those directly benefited, although assigning benefit may be difficult. In general, the special benefit to the property is defined as the difference between the fair market value of the property before and after the improvement. Local improvement districts may present administrative challenges due to the funds tracking required to account for a number of separate parcels. Implementation can be cumbersome and risky, depending on the formation process undertaken. Local improvement districts work best when used to fund specific local improvements. Regional facilities create problems with both the allocation of the project cost to individual benefiting properties and the additional administrative burden.

Conventional Debt Instruments

The most commonly used long-term debt instruments are revenue and general obligation bonds. Bond anticipation notes are available for short-term interim capital financing. Issuing debt can be used for capital funding only, not operations.

Revenue bonds are the most common source of funds for construction of major utility improvements. Revenue bond debt service is paid out of utility rate and capital facilities charge revenues. There are no statutory limitations on the amount of revenue bonds a city can issue, although the utility is required to meet a yearly net operating income coverage requirement of up to 1.5 times the annual debt service. The terms on revenue bonds are not as favorable as general obligation bonds, but they carry the advantage of leaving the city's debt capacity undisturbed. Interest rates vary depending on market conditions.

General obligation bonds are secured by the taxing power of the city and are typically paid through property tax revenues. However, the city may choose to repay the debt from utility revenues, using property tax revenues only if the utility fails to meet its debt obligation. The financing costs of general obligation bonds are lower than for revenue bonds, due to 1) lower interest rates available, 2) no coverage requirements, and 3) no reserve requirements.

Short-term interim financing mechanisms are also available to meet capital costs. Bond anticipation notes can provide interim financing during construction while allowing flexibility in the choice of long-term financing instruments. Typically, bond anticipation notes have lower interest rates than bonds, but they add to issuance costs.

Interjurisdictional Cost Sharing

Surface water runoff does not follow corporate boundaries and often passes from one jurisdictional entity to another. Portions of the city of Tukwila receive and convey runoff from King County, the cities of SeaTac and Seattle, the Port of Seattle, and the Washington State Department of Transportation. Runoff from the city of Tukwila similarly passes through other jurisdictions such as the city of Renton. Forming interlocal agreements to share the cost of capital projects that may serve several jurisdictions is possible.

An excellent example of an interjurisdictional effort is the Des Moines Creek Basin Program. Through an ongoing interlocal agreement, King County, the cities of Des Moines and Tukwila, and the Port of Seattle funded the preparation of a basin plan. The plan identifies problems and recommended solutions in the overall basin. Through this interjurisdictional effort, a plan was developed for addressing water quality issues, developing prioritized capital improvement project recommendations, and cooperative funding. The plan recommends over $6 million worth of capital improvements that are to be funded through cost sharing. The cost sharing is based upon both the fraction of the basin area within each jurisdiction and the fraction of the total impervious surface area in the basin within each jurisdiction. A basin committee, with representation from each jurisdiction, was formed to meet regularly and work toward implementation of the capital projects.

Similar opportunities exist for the city of Tukwila, in particular the Gilliam Creek basin. The city of SeaTac and the Washington State Department of Transportation make up a substantial portion of the basin.

Fees in Lieu of Onsite Construction

Fees in lieu of onsite construction allow developers to pay a fee to the city instead of constructing onsite stormwater facilities to meet development or redevelopment requirements. The fee must be used by the city to build regional or onsite facilities designed to meet the same objectives as the onsite requirements. Like capital facilities charges, fee proceeds are available for capital facilities only, and their reliability depends on the consistency of growth and redevelopment.

For redevelopment, the development community would likely prefer paying a fee instead of redeveloping the drainage infrastructure at a site, because it is very costly to retrofit a redevelopment site to provide stormwater quantity and quality controls. Current city code requires redevelopment to provide water quality treatment facilities for the entire site if the project cost is greater than $500,000 (or $100,000 for a high-use site). But it may be difficult for the city to locate a suitable site for those controls if the area is highly developed. There are also disadvantages with timing. To be in compliance with stormwater regulations, any regional facility must be operational by the time the initial development is complete. This would require the city to construct a regional facility prior to completion of any new development that is planning to use the facility. If the city is intending to use the initial fee as only a portion of the cost to build a regional facility, the city would need to secure the remaining financing in advance to build the project. The costs could be paid off as subsequent development pays the fee. Unless a unique set of circumstances favors this approach, this method should not be considered a reliable secondary funding source.

Developer Participation

Developer participation describes an approach in which a developer either constructs or helps fund a capital improvement project as a condition of development. In some cases, the city gains by reducing the cost to ratepayers and the developer gains by speeding the process of making

land developable. For example, a developer could construct a "public" stormwater management facility or a storm drainage conveyance capacity improvement project, as identified in an adopted capital improvement plan, and thus should be eligible for reimbursement. The amount of reimbursement should be limited to the proportionate cost of providing capacity over and above that needed by the developing property. This option should be available for both water quality and water quantity improvements. A developer who constructs a conveyance system or a regional facility may be eligible for a latecomer agreement. The following discussion of latecomer agreements is broken down into areas, conveyance systems, and regional control facilities.

Latecomer Fees – Conveyance Systems

In addition to (or instead of) providing onsite stormwater control facilities, commercial, institutional, industrial, and multifamily developers may be required to provide or upsize the conveyance system serving their parcels. To the extent that the developer increases conveyance capacity beyond the capacity needed to serve his parcel, then the city may allow the developer to recover the cost of upsizing by charging a latecomer fee.

To recover these added costs for upsized facilities, the developer (or city acting for the developer) could charge a latecomer fee. This fee is assessed to other parcels that will be served by the conveyance capacity provided by the initial developing property. The proceeds of the latecomer fees would be remitted to the initial developer as a reimbursement for constructing additional conveyance capacity.

The following formula is an example of charges assessed latecomers for the reimbursement of customers who have provided conveyance capacity that exceeds their property-specific requirements and is available to serve subsequently developing properties:

$$L = M \ x \ \frac{(Ca - Cr)}{Ca} \ / \ D$$

where:

L = charge per front foot to latecomers to be collected by city or developer and remitted to the provider of additional conveyance capacity (less 10 percent for processing)

M = cost of project (conveyance only)

Ca = capacity added to existing or non-existing conveyance system

Cr = capacity required to meet post-development conveyance demands of credit applicant

D = developable front footage to be served by additional conveyance capacity.

Reimbursement under this approach is limited by statute (RCW 35.91.020) to 15 years.

Latecomer Fees – Regional Stormwater Control Facilities

Establishing a latecomer agreement for a regional stormwater control facility is administratively complex, in part due to the difficulties of determining an equitable method to charge future developing properties (similar to local improvement districts). Some of the difficulties include:

- If the drainage area tributary to the regional facility is partially developed, (as is most of the city), it would be made up of both undeveloped and developed properties. Thus it would be difficult to develop a formula to arrive at a cost to pay back the original developer, because it would be difficult to predict the extent to which future development in combination with redevelopment would occur. This prediction would be necessary to arrive at a total future improvement area and equitable cost that would be charged to future development.

- Due to the timing of both development and redevelopment, it would be uncertain when and to what extent the original developer would be reimbursed, within the statutory time limit of 15 years.

- Other developing or redeveloping areas within the same tributary drainage area could choose to build an onsite facility rather than participate in a regional facility.

For these reasons, a latecomer agreement for regional facilities should not be considered as a reliable secondary funding source.

Summary

The purpose of this review was to identify potential funding mechanisms to supplement the primary utility service fee and finance capital improvements. Following are some conclusions and recommendations developed during this review.

- The city of Tukwila should continue to pursue applicable grants and loans. These special funding sources, although difficult to obtain, can significantly reduce the city's costs for capital projects.

- The city should implement a system development charge for new development and redevelopment. This one-time charge would provide funding for future capital projects.

- The city should increase permit review fees to directly cover the cost of staff effort on development review.

- The city of Tukwila should seek opportunities to form cost sharing opportunities with other jurisdictions. The city of SeaTac and the Washington State Department of Transportation are responsible for a significant portion of the Gilliam Creek basin. The city of Tukwila should also continue to leverage cost sharing through the Green River Basin Program.

- Under favorable circumstances, the city could encourage developer participation in regional stormwater facilities. However, in highly developed basins, this should be approached with caution. In the already highly developed Gilliam Creek basin, there are few sites remaining for regional detention and water quality treatment. Therefore, the city may wish to concentrate on using these sites for retrofitting areas with undetained and untreated runoff, and encourage developers to provide detention and treatment within their parcels.

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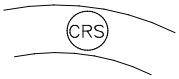
Section 7.0 Attachments

(No Attachments)

Section 8.0 Attachments

D.2.1.4.2 CONSTRUCTION ROAD/PARKING AREA STABILIZATION

Code: CRS Symbol: 

Purpose

Stabilizing subdivision roads, parking areas and other onsite vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

1. Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.
2. Fencing (see Section D.2.1.1) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

1. A 6-inch depth of 2- to 4-inch **crushed rock, gravel base, or crushed surfacing base course** shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade. *Note: If the area will be used for permanent road or parking installation later in the project, the subgrade will be subject to inspection.*
2. **Temporary road gradients** shall not exceed 15 percent. Roadways shall be carefully graded to drain transversely. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be designed in accordance with the standards given in Section D.2.1.6.4 (p. D-64) and directed to a sediment pond or trap.
3. Rather than relying on ditches, it may also be possible to **grade the road** so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include vegetated wetlands. If runoff is allowed to sheet flow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
4. In order to control construction traffic, the County may require that **signs** be erected on site informing construction personnel that vehicles, other than those performing clearing and grading, are restricted to stabilized areas.
5. If construction roads do not adequately reduce trackout to adjacent property or roadways, a wheel wash system will be required.

Maintenance Standards

Crushed rock, gravel base, hog fuel, etc. shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.

D.2.1.5 SEDIMENT RETENTION

Surface water collected from disturbed areas of the site shall be routed through a sediment pond or trap prior to release from the site. An exception is for areas at the perimeter of the site with drainage areas small enough to be treated solely with perimeter protection (see Section D.2.1.3, p. D-33). Also, if the soils and topography are such that no offsite discharge of surface water is anticipated up to and including the developed 2-year runoff event, sediment ponds and traps are not required. A 10-year peak flow using the approved model with 15-minute time steps shall be used for sediment pond/trap sizing if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection (see below). At the County's discretion, sites may be worked during the dry season without sediment ponds and traps if there is some other form of protection of surface waters, such as a 100-foot forested buffer between the disturbed areas and adjacent surface waters. For small sites, use the criteria defined in Section D.2.1.3, Perimeter Protection to determine minimum flow path length. If the site work has to be extended into the wet season, a back-up plan must be identified in the CSWPP plan and implemented. Protection of catch basins is required for inlets that are likely to be impacted by sediment generated by the project and that do not drain to an onsite sediment pond or trap. Sediment retention facilities shall be installed prior to grading of any contributing area and shall be located so as to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.

Purpose: The purpose of sediment retention facilities is to remove sediment from runoff generated from disturbed areas.

When to Install: The facilities shall be constructed as the first step in the clearing and grading of the site. The surface water conveyances may then be connected to the facilities as site development proceeds.

Measures to Use: There are three sediment retention measures in this section. The first two, sediment traps and ponds, serve the same function but for different size catchments. All runoff from disturbed areas must be routed through a trap or pond except for very small areas at the perimeter of the site small enough to be treated solely with perimeter protection (see Section D.2.1.3, p. D-33). The third measure is for catch basin protection. It is only to be used in limited circumstances and is not a primary sediment treatment facility. It is only intended as a backup in the event of failure of other onsite systems.

Use of Permanent Drainage Facilities: All projects that are constructing permanent facilities for runoff quantity control are strongly encouraged to use the rough-graded or final-graded permanent facilities for ponds and traps. This includes combined facilities and infiltration facilities. When permanent facilities are used as temporary sedimentation facilities, the surface area requirements of sediment traps (for drainages less than 3 acres) or sediment ponds (more than 3 acres) must be met. If the surface area requirements are larger than the surface area of the permanent facility, then the pond shall be enlarged to comply with the surface area requirement. The permanent pond shall also be divided into two cells as required for sediment ponds. Either a permanent control structure or the temporary control structure described in Section D.2.1.5.2 may be used. If a permanent control structure is used, it may be advisable to partially restrict the lower orifice with gravel to increase residence time while still allowing dewatering of the pond.

If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of three feet above final grade. Excavation should be done with a backhoe working at "arms length" to minimize disturbance and compaction of the infiltration surface. Additionally, any required pretreatment facilities shall be fully constructed prior to any release of sediment-laden water to the facility. Pretreatment and shallow excavation are intended to prevent the clogging of soil with fines. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized (see Section D.2.4.5, p. D-115).

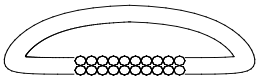
Selection of the Design Storm: In most circumstances, the developed condition 2-year peak flow using the approved model with 15-minute time steps is sufficient for calculating surface area for ponds and traps and for determining exemptions from the sediment retention and surface water collection requirements

(Sections D.2.1.5 and D.2.1.6, respectively). In some circumstances, however, the approved model 10-year 15-minute peak flow should be used. Examples of such circumstances include the following:

- Sites that are within ¼ mile of salmonid streams, wetlands, and designated sensitive lakes such as Lake Sammamish
- Sites where significant clearing and grading is likely to occur during the wet season
- Sites with downstream erosion or sedimentation problems.

Natural Vegetation: Whenever possible, sediment-laden water shall be discharged into onsite, relatively level, vegetated areas. This is the only way to effectively remove fine particles from runoff. This can be particularly useful after initial treatment in a sediment retention facility. The areas of release must be evaluated on a site-by-site basis in order to determine appropriate locations for and methods of releasing runoff. Vegetated wetlands shall not be used for this purpose. Frequently, it may be possible to pump water from the collection point at the downhill end of the site to an upslope vegetated area. Pumping shall only augment the treatment system, not replace it because of the possibility of pump failure or runoff volume in excess of pump capacity.

D.2.1.5.1 SEDIMENT TRAP

Code: ST Symbol: 

Purpose

Sediment traps remove sediment from runoff originating from disturbed areas of the site. Sediment traps are typically designed to only remove sediment as small as medium silt (0.02 mm). As a consequence, they usually only result in a small reduction in turbidity.

Conditions of Use

A sediment trap shall be used where the contributing drainage area is 3 acres or less.

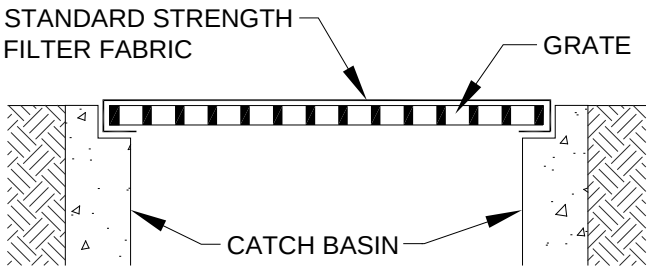
Design and Installation Specifications

1. See Figure D.2.1.5.A for details.
2. If permanent runoff control facilities are part of the project, they should be used for sediment retention (see "**Use of Permanent Drainage Facilities**" on page D-47).
3. To determine the trap geometry, first calculate the design surface area (*SA*) of the trap, measured at the invert of the weir. Use the following equation:

$$SA = FS(Q_2/V_S)$$

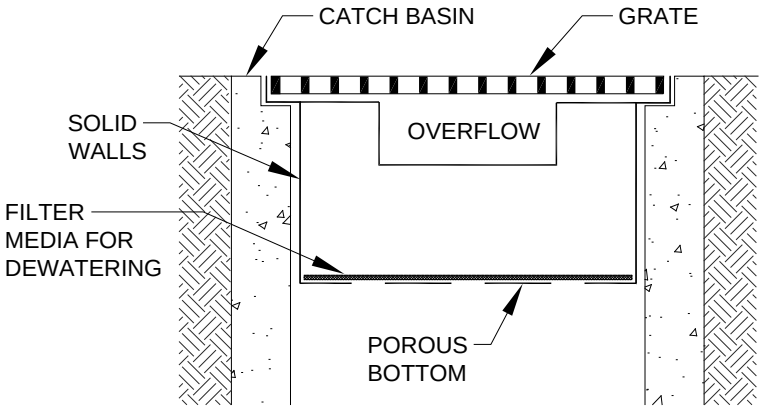
where Q_2 = Design inflow (cfs) from the contributing drainage area based on the developed condition 2-year or 10-year peak discharge using the approved model with 15-minute time steps as computed in the hydrologic analysis. The approved model 10-year 15-minute peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection, or if the pond discharge path leaves the ***site*** (note provisions must made to prevent increases in the existing site conditions 2-year and 10-year runoff peaks discharging from the project ***site*** during construction, see Section D.3.9, Flow Control). If no hydrologic analysis is required, the Rational Method may be used (Section 3.2.1 of the King County *Surface Water Design Manual*).

FIGURE D.2.1.5.E FILTER FABRIC PROTECTION



NOTE: ONLY TO BE USED WHERE PONDING OF WATER ABOVE THE CATCH BASIN WILL NOT CAUSE TRAFFIC PROBLEMS AND WHERE OVERFLOW WILL NOT RESULT IN EROSION OF SLOPES.

FIGURE D.2.1.5.F CATCH BASIN INSERT



NOTE: THIS DETAIL IS ONLY SCHEMATIC. ANY INSERT IS ALLOWED THAT HAS:

- A MIN. 0.5 C.F. OF STORAGE,
- THE MEANS TO DEWATER THE STORED SEDIMENT,
- AN OVERFLOW, AND
- CAN BE EASILY MAINTAINED.

D.2.1.6 SURFACE WATER COLLECTION

All surface water from disturbed areas shall be intercepted, conveyed to a sediment pond or trap, and discharged downslope of any disturbed areas. An exception is for areas at the perimeter of the site with drainage areas small enough to be treated solely with perimeter protection (see Section D.2.1.3). Also, if the soils and topography are such that no offsite discharge of surface water is anticipated up to and including the developed 2-year runoff event, surface water controls are not required. A 10-year approved model 15-minute peak flow shall be used for sizing surface water controls if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection (see the introduction to Section D.2.1.5). At the County's discretion, sites may be worked during the dry season without surface water controls, if there is some other form of protection of surface waters, such as a 100-foot forested buffer between the disturbed areas and adjacent surface waters. Significant sources of upslope surface water that drain onto disturbed areas shall be intercepted and conveyed to a stabilized discharge point downslope of the disturbed areas. Surface water controls shall be installed concurrently with rough grading.

Purpose: The purpose of surface water control is to collect and convey surface water so that erosion is minimized, and runoff from disturbed areas is treated by a sediment pond or trap. Surface water control essentially consists of three elements:

1. Interception of runoff on and above slopes
2. Conveyance of the runoff to a sediment pond or trap (if the runoff was collected from a disturbed area)
3. Release of the runoff downslope of any disturbed areas.

When to Install: Surface water controls shall be constructed during the initial grading of an area and must be in place before there is any opportunity for storm runoff to cause erosion.

Measures to Install: Interceptor dikes/swales intercept runoff, ditches and pipe slope drains convey the runoff, and riprap or level spreaders help release the runoff in a non-erosive manner. Each measure is to be used under different circumstances so there is very little overlap. However, the two options for releasing water in a non-erosive manner, outlet protection and level spreaders, can be somewhat interchangeable. See Figure D.2.1.6.A for a schematic drawing demonstrating the use of these measures.

D.2.1.7 DEWATERING CONTROL

Any runoff generated by dewatering shall be treated through construction of a sediment trap (Section D.2.1.5.1) when there is sufficient space or by releasing the water to a well vegetated, gently sloping area. Since pumps are used for dewatering, it may be possible to pump the sediment-laden water well away from the surface water so that vegetation can be more effectively utilized for treatment. Discharge of sediment-laden water from dewatering activities to surface and storm waters is prohibited. If dewatering occurs from areas where the water has come in contact with new concrete, such as tanks, vaults, or foundations, the pH of the water must be monitored and must be neutralized prior to discharge. Clean non-turbid dewatering water, such as well point ground water can be discharged to systems tributary to, or directly to surface waters provided the flows are controlled so no erosion or flooding occurs. Clean water must not be routed through a stormwater sediment pond. Highly turbid or contaminated dewatering water must be handled separately from stormwater.

Purpose: To prevent the untreated discharge of sediment-laden water from dewatering of utilities, excavated areas, foundations, etc.

When to Install: Dewatering control measures shall be used whenever there is a potential for runoff from dewatering of utilities, excavations, foundations, etc.

Measures to install:

1. Foundation, vault, excavation, and trench dewatering water that has similar characteristics to stormwater runoff at the site shall be discharged into a controlled conveyance system prior to discharge to a sediment trap or sediment pond. Foundation and trench dewatering water **that has similar characteristics to stormwater runoff** at the site must be disposed of through one of the following options depending on site constraints:
   a) Infiltration,
   b) Transport offsite in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute surface waters,
   c) Discharge to the sanitary sewer discharge with local sewer district approval if there is no other option, or
   d) Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.
2. Clean, non-turbid dewatering water, such as well-point ground water, may be discharged via stable conveyance to systems tributary to surface waters, provided the dewatering flow does not cause erosion or flooding of receiving waters.
3. **Highly turbid or contaminated dewatering water (high pH or other) shall be handled separately** from stormwater. See Section D.2.2 (p. D-74), *SWPPS Measures*.

D.2.1.8 DUST CONTROL

Preventative measures to minimize the wind transport of soil shall be taken when a traffic hazard may be created or when sediment transported by wind is likely to be deposited in water resources or adjacent properties.

Purpose: To prevent wind transport of dust from exposed soil surfaces onto roadways, drainage ways, and surface waters.

When to Install: Dust control shall be implemented when exposed soils are dry to the point that wind transport is possible and roadways, drainage ways, or surface waters are likely to be impacted. Dust control measures may consist of chemical, structural, or mechanical methods.

Measures to Install: Water is the most common dust control (or palliative) used in the area. When using water for dust control, the exposed soils shall be sprayed until wet, but runoff shall not be generated by spraying. Calcium chloride, Magnesium chloride, Lignin derivatives, Tree Resin Emulsions, and Synthetic Polymer Emulsions may also be used for dust control. Exposed areas shall be re-sprayed as needed. Oil shall not be used for dust control. The following table lists many common dust control measures. Some of the measures are not recommended for use in King County and must have prior approval prior to use from the DPER inspector assigned to specific projects.

TABLE D.2.1.8.A DUST CONTROL MEASURES

METHOD	CONSIDERATIONS	SITE PREPARATION	RECOMMENDED APPLICATION RATE
Water	-Most commonly used practice -Evaporates quickly -Lasts less than 1 day	For all liquid agents: -Blade a small surface -Crown or slope surface to avoid ponding -Compact soils if needed -Uniformly pre-wet at 0.03 – 0.3 gal/sq yd -Apply solution under pressure. Overlap solution 6 – 12 inches -Allow treated area to cure 0 – 4 hours -Compact area after curing -Apply second treatment before first treatment becomes ineffective	0.125 gal/sq yd every 20 to 30 minutes
Salts Calcium Chloride (CaCl)	-Restricts evaporation -Lasts 6-12 months -Can be corrosive -Less effective in low humidity -Can build up in soils and leach by rain		Apply 38% solution at 1.21L/m2 (0.27 gal/yd2) or as loose dry granules per manufacturer
Magnesium Chloride (MgCl)	-Restricts evaporation -Works at higher temperatures and lower humidity than CaCl -May be more costly than CaCl		Apply 26 – 32% solution at 2.3 L/m2 (0.5 gal/yd2)
Sodium Chloride (NaCl)	-Effective over smaller range of conditions -Less expensive -Can be corrosive -Less effective in low humidity		Per Manufacturer
Silicates	-Generally expensive -Available in small quantities -Require Second application		
Surfactants	-High evaporation rates -Effective for short time periods -Must apply frequently		
Copolymers	-Forms semi-permeable transparent crust -Resists ultraviolet radiation and moisture induced breakdown -Last 1 to 2 years		750 – 940 L/ha (80 – 100 gal/ac)
Petroleum Products	-Used oil is prohibited as a dust control method -Bind soil particles -May hinder foliage growth -Environmental and aesthetic concerns -Higher cost		Use 57 – 63% resins as base. Apply at 750 – 940 L/ha (80-100 gal/ac)
Lignin Sulfonate	-Paper industry waste product -Acts as dispersing agent -Best in dry climates -Can be slippery -Will decrease Dissolved Oxygen in waterways therefore cannot be used adjacent to surface water systems		Loosen surface 25-50 mm (1 – 2 inches) Need 4-8% fines
Vegetable Oils	-Coat grains of soils, so limited binding ability -May become brittle -Limited availability		Per Manufacturer
Spray on Adhesives	-Available as organic or synthetic -Effective on dry, hard soils -Forms a crust -Can last 3 to 4 years		Per Manufacturer

D.2.1.9 FLOW CONTROL

Surface water from disturbed areas must be routed through the project's onsite flow control facility or other provisions must made to prevent increases in the existing site conditions 2-year and 10-year runoff peaks discharging from the project site during construction.

Purpose: The purpose of surface water flow control is to mitigate increases in runoff peaks that occur during construction as a result of clearing vegetation, compacting the soil, and adding impervious surface. Such increases can cause or aggravate downstream flooding and erosion.

When to Install: Surface water flow control shall be installed or otherwise provided prior to any clearing and/or grading of the site, except that required to construct the surface water flow control facilities.

Measures to Use: The project's onsite flow control facility or other equivalent storage facility that meets the peak-matching performance criteria stated above.

D.2.1.10 PROTECT EXISTING AND PROPOSED FLOW CONTROL BMPS

Protection measures shall be applied/installed and maintained so as to prevent adverse impacts to existing flow control BMPs and areas of proposed flow control BMPs for the project. Adverse impacts can prompt the requirement to restore or replace affected BMPs.

Purpose: The purpose of protecting existing and proposed flow control BMP areas is to avoid sedimentation and soil compaction that would adversely affect infiltration, and also avoid contamination by other pollutants.

When to Install: Flow control BMP area protection shall be installed or otherwise provided prior to any clearing and/or grading of the site, except that required to construct flow control BMPs.

Measures to Use:

1. Protect all flow control BMPs and proposed BMP footprints from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the flow control BMPs.
2. BMPs shall be restored to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP shall include, at a minimum, removal of sediment and any sediment-laden bioretention soils, and replacing the removed soils with soils meeting the design specification. Replacement with a new fully-functioning BMP may be required if restoration to the fully-functioning condition can’t be accomplished.
3. Prevent compacting Bioretention BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.
4. Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements.
5. Pavements fouled with sediments or no longer passing an initial infiltration text must be cleaned using procedures from the local stormwater manual or the manufacturer’s procedures.
6. Keep all heavy equipment off existing soils under flow control BMPs that have been excavated to final grade to retain the infiltration rate of the soils.

Additional Guidance

See Chapter 5: Precision Site Preparation and Construction in the *LID Technical Guidance Manual for Puget Sound* for more detail on protecting LID integrated management practices. Note that the LID Technical Guidance Manual for Puget Sound (2012) is for additional informational purposes only. The

guidance within this manual must be followed if there are any discrepancies between this manual and the LID Technical Guidance Manual for Puget Sound (2012).

D.2.1.11 MAINTAIN PROTECTIVE BMPS

Protection measures shall be maintained to assure continued performance of their intended function, to prevent adverse impacts to existing flow control BMPs and areas of proposed flow control BMPs, and protect other disturbed areas of the project.

Purpose: The purpose of maintaining protective BMPs is to provide continuous erosion and sediment control protection throughout the life of the project, and avoid sedimentation, soil compaction and contamination by other pollutants that would adversely affect infiltration and surface runoff.

When to Maintain: Protection measures shall be monitored per Section D.2.4.4 at a minimum, and promptly maintained to fully functioning condition as necessary to assure continued performance of their intended function.

Measures to Use:

1. Maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.
2. Remove all temporary erosion and sediment control BMPs prior to final construction approval, or within 30 days after achieving *final* site stabilization or after the temporary BMPs are no longer needed.
3. Provide protection to all BMPs installed for the permanent control of stormwater from sediment and compaction. All BMPs that are to remain in place following completion of construction shall be examined and placed in full operating conditions. If sediment enters the BMPs during construction, it shall be removed and the BMP shall be returned to the conditions specified in the construction documents or as required for full BMP replacement.
4. Remove or stabilize trapped sediment on site. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.

D.2.1.12 MANAGE THE PROJECT

Coordination and timing of site development activities relative to ESC concerns (Section D.2.4), and timely inspection, maintenance and update of protective measures (Section D.2.3) are necessary to effectively manage the project and assure the success of protective ESC and SWPPS design and implementation.

Projects shall assign a qualified CSWPP Supervisor (Section D.2.3.1) to be the primary contact for ESC and SWPPP issues and reporting, coordination with subcontractors and implementation of the CSWPP plan as a whole.

Measures to Use:

1. Phase development projects to the maximum degree practicable and take into account seasonal work limits.
2. Inspection and monitoring – Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Conduct site inspections and monitoring in accordance with the Construction Stormwater General Permit and King County requirements.
3. Maintaining an updated construction SWPPP – Maintain, update, and implement the SWPPP in accordance with the Construction Stormwater General Permit and King County requirements.
4. Projects that disturb one or more acres must have, site inspections conducted by a Certified Erosion and Sediment Control Lead (CESCL) (see Section D.2.3.1). Project sites less than one acre (not part

of a larger common plan of development or sale) may have a person without CESCL certification conduct inspections. By the initiation of construction, the SWPPP must identify the CESCL or inspector, who shall be present on-site or on-call at all times.

The CESCL or inspector (project sites less than one acre) must have the skills to assess the:

- Site conditions and construction activities that could impact the quality of stormwater.
- Effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- The CESCL or inspector must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen. They must evaluate the effectiveness of BMPs and determine if it is necessary to install, maintain, or repair BMPs to improve the quality of stormwater discharges.

Based on the results of the inspection, construction site operators must correct the problems identified by:

- Reviewing the SWPPP for compliance with all construction SWPPP elements and making appropriate revisions within 7 days of the inspection.
- Immediately beginning the process of fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible, addressing the problems not later than within 10 days of the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, the construction site operator may request an extension within the initial 10-day response period.
- Documenting BMP implementation and maintenance in the site log book (applies only to sites that have coverage under the Construction Stormwater General Permit).
- The CESCL or inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition, individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week.) The CESCL or inspector may reduce the inspection frequency for temporary stabilized, inactive sites to once every calendar month

D.2.2 SWPPS MEASURES

This section details the SWPPS measures that are required to prevent, reduce, or eliminate the discharge of pollutants to onsite or adjacent stormwater systems or watercourses from construction-related activities such as materials delivery and storage, onsite equipment fueling and maintenance, demolition of existing buildings and disposition of demolition materials and other waste, and concrete handling, washout and disposal.. These SWPPS measures represent *Best Management Practices (BMPs)*[8] for the control of pollutant drips and spills as well as other impacts related to construction such as increased pH in concrete construction and handling activities. Compliance with each of the SWPPS measures, and with any project-specific control measures, to the extent applicable and necessary to meet the performance criteria in Section D.2.2, and compliance with the CSWPP implementation requirements in Section D.2.4, constitutes overall compliance with King County's CSWPP Standards.

Note: Additional measures shall be required by the County if the existing standards are insufficient to protect adjacent properties, drainage facilities, or water resources.

The standards for each individual SWPPS measure are divided into four sections:

1. Purpose
2. Conditions of Use
3. Design and Installation Specifications
4. Maintenance Requirements.

Note that the "Conditions of Use" always refers to site conditions. As site conditions change, SWPPS measures must be changed to remain in compliance with the requirements of this appendix.

Whenever compliance with King County SWPPS Standards is required, all of the following SWPPS measures must be considered for application to the project site as detailed in the following sections. The construction pollutant generating concerns addressed by the BMPs that follow include:

- Concrete handling, washout and disposal(specifically portland cement concrete)
- Sawcutting and surfacing activities
- Materials delivery, storage and containment
- Filtration and chemical treatment of construction water to facilitate disposal or discharge to approved locations
- Reporting requirements and documentation availability for specific BMP processes

Additionally, several of the ESC BMPs described in Section D.2.1 can be applicable to the SWPPS plan, e.g., use of cover, fencing and access protection to protect temporary materials storage locations. The applicant’s material supplier may be a resource (subject to King County approval) for BMPs to address specific project applications or proposals. Conditions of approval on adjustments may also specify additional requirements for the SWPPS plan.

[8] *Best Management Practices (BMPs)* means the best available and reasonable physical, structural, managerial, or behavioral activities, that when singly or in combination, eliminate or reduce the contamination of surface and/or ground waters.

D.2.2.1 CONCRETE HANDLING

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the state.

Conditions of Use

Any time concrete is used, utilize these management practices. Concrete construction projects include, but are not limited to, curbs, sidewalks, roads, bridges, foundations, floors, stormwater vaults, retaining walls, driveways and runways.

Design and Installation Specifications

1. Assure that washout of concrete trucks, chutes, pumps, and internals is performed at an approved off-site location or in designated concrete washout areas. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Refer to BMP D.2.2.2 (p. D-76) for information on concrete washout areas.
2. Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete on site, except in designated concrete washout areas.
3. Wash off hand tools including, but not limited to, screeds, shovels, rakes, floats, and trowels into formed areas only.
4. Wash equipment difficult to move, such as concrete pavers in areas that do not directly drain to natural or constructed stormwater conveyances.
5. Do not allow washdown from areas, such as concrete aggregate driveways, to drain directly to natural or constructed stormwater conveyances.
6. Contain washwater and leftover product in a lined container when no formed areas are available,. Dispose of contained concrete in a manner that does not violate ground water or surface water quality standards.
7. Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
8. Refer to BMPs D.2.2.7 and D.2.2.8 for pH adjustment requirements.
9. Refer to the Construction Stormwater General Permit for pH monitoring requirements if the project involves one of the following activities:
    - Significant concrete work (greater than 1,000 cubic yards poured concrete or recycled concrete used over the life of a project).
    - The use of engineered soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.
    - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

Check containers for holes in the liner daily during concrete pours and repair the same day.

D.2.2.3 SAWCUTTING AND SURFACING POLLUTION PREVENTION

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to, sawing, coring, grinding, roughening, hydro-demolition, bridge and road surfacing

Design and Installation Specifications

1. Vacuum slurry and cuttings during cutting and surfacing operations.
2. Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
3. Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
4. Dispose of collected slurry and cuttings in a manner that does not violate ground water or surface water quality standards.
5. Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose process water in a manner that does not violate ground water or surface water quality standards.
6. Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

D.2.2.4 MATERIAL DELIVERY, STORAGE AND CONTAINMENT

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials on-site, store materials in a designated area, and install secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g. Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

The following steps should be taken to minimize risk:

1. Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
2. Material Safety Data Sheets (MSDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
3. Hazardous material storage on-site should be minimized.
4. Hazardous materials should be handled as infrequently as possible.
5. During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.
6. Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
7. Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, and within secondary containment.
8. If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Material Storage Areas and Secondary Containment Practices:

1. Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.
2. Temporary secondary containment facilities shall provide for a spill containment volume able to contain 10% of the total enclosed container volume of all containers, or 110% of the capacity of the largest container within its boundary, whichever is greater.

3. Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.
4. Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.
5. Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
6. During the wet weather season (Oct 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.
7. Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).
8. The spill kit should include, at a minimum:
    - 1-Water Resistant Nylon Bag
    - 3-Oil Absorbent Socks 3”x 4’
    - 2-Oil Absorbent Socks 3”x 10’
    - 12-Oil Absorbent Pads 17”x19”
    - 1-Pair Splash Resistant Goggles
    - 3-Pair Nitrile Gloves
    - 10-Disposable Bags with Ties
    - Instructions

TABLE D.2.2.9.A CTB/CKD Soil Amendment BMPs

Category of Action	Specific Action	CTB/CKD Best Management Practices
3. Lay-down Mixing Equipment		A. Exposure of CTB/CKD materials to air to be minimized. Delivery tankers shall be set up to place CTB/CKD directly into spreading trucks or equipment. B. CTB/CKD operations are only allowed during daylight hours. C. Tarps or dust bags will be used over the discharge truck hose at unloading to prevent dust particles for becoming airborne. D. Unloading will occur at the lowest possible pump pressure. E. Unloading and mixing will be avoided on high wind days. PSAPCA Section 9.15 prohibits visible emissions of fugitive dust. F. CTB/CKD to be placed on ground by large wheeled spreaders designed for this purpose capable of measuring application. G. When spreading CTB/CKD it shall be kept 2-3 feet away from untreated areas boundaries to prevent the material from migration and contaminating outside the treatment zone. H. Treatment area will be kept damp/wet at all times CTB/CKD is being spread and mixed. Skirting around applicator/spreader and mixer is required to minimize CTB/CKD dust. I. CTB/CKD is to be roto-tilled into soil immediately after being spread onto soils and shall be done with a skirted tiller. J. Direct auguring machine that measures, spreads, and mixes CTB/CKD in one operation is preferred. K. Compaction will be complete within 2 hours after CTB/CKD application.

TABLE D.2.2.9.A CTB/CKD Soil Amendment BMPs		
Category of Action	**Specific Action**	**CTB/CKD Best Management Practices**
4. Site Management	Work Progress and Weather Conditions	A. Dust suppression by use of water trucks shall be used on areas where work on dry soil is performed and potential airborne contamination may occur. B. The volume of CTB/CKD allowed on site will be limited to the amount that can be used within a normal workday. Every effort will be made to forecast the daily delivery rate to match the daily on-site use rate. C. CTB/CKD will not be added to soils at a rate that exceeds the ability of on-site resources to immediately commence mixing and compacting. D. No work will occur in rain heavier than drizzle, or under drizzle that exceeds 6 hours duration, or under any rainfall which generates runoff from the areas being worked. E. Should the weather change to stop the application, remaining CTB/CKD will be covered and contained to prevent stormwater from entering storage containment, and causing runoff. F. All vehicles and equipment leaving the treatment area/site must be cleaned/washed to prevent CTB/CKD from leaving site. Wash water will be contained and treated as needed. G. CTB/CKD contact water in the wheel wash will be removed from the site via a vactor truck for transport to an approved off-site treatment or disposal facility in accordance with all federal, state, and local laws and regulations; or, if permitted, to the sanitary sewer system.
5. Surface Water Collection		A. Surface runoff from the treated areas is to be collected and stored in onsite sealed treatment tanks. B. A rigid schedule of TESC inspection, maintenance, and drainage controls will be maintained. C. Temporarily plugging and using detention facilities is not allowed as a storage practice. D. Runoff from compacted areas amended with CTB/CKD will be directed to previously sealed tank(s) until pH levels of water are verified to be within acceptable background water limits. No uncontrolled discharge or infiltration from the sealed tank(s) will be allowed. E. Drainage from areas amended with CTB/CKD within the past 72 hours will be prevented from co-mingling with any other project drainage.

TABLE D.2.2.9.A CTB/CKD Soil Amendment BMPs

Category of Action	Specific Action	CTB/CKD Best Management Practices
6. Discharge Compliance	Applicable Regulations	A. Any and all discharges from this site will be in compliance with all applicable federal, state, and local laws and regulations pertaining to health and safety, water, air, waste, and wildlife, including the Federal Clean Water Act, Clean Air Act, and Endangered Species Act. Laboratory analysis of water is required prior to discharge to verify compliance. B. No infiltration is allowed to occur if pH readings are above 8.5 standard pH units, or below 6.5 standard pH units. C. A pH meter must be used to determine levels. pH meter is to be calibrated following proper QA/QC procedures. Fresh buffers are to be available to re-calibrate as needed. D. A log of turbidity and pH readings will be kept on site for inspection. E. All treatment of water must be directed, bench tested, monitored and verified by a qualified water quality specialist. F. Treated area water runoff shall not enter the permanent stormwater system. G. Stormwater drainage system within treatment area is to be cleaned out prior to use for regular water runoff conveyance from untreated areas. Water from cleanout is to be tested and treated following the approved treatment criteria.
7. Natural Treatment and Discharge		A. The preferred method of disposal of the treatment water will be discharge to the sanitary sewer, provided a permit is obtained to do so. B. If infiltration is proposed, the area of infiltration is to be identified, capacity confirmed, and a contingency discharge plan in place in the event facilities fail to infiltrate. C. For infiltration, pH limits shall be strictly adhered to. D. If a permit to discharge to the sanitary sewer is not obtained, a National Pollutant Discharge Elimination System (NPDES) discharge permit is required from Ecology. The retention volume of the lined pond(s) will also be increased to ensure complete control of the retained volume. Monitoring, bench testing, and controlled discharge rates, with prior approval by Ecology, would be needed prior to discharge to an approved off-site surface drainage system. Sites that currently have NPDES permits will need to amend permit prior to discharge to cover this action. County approval is still required. E. Per KCC 9.12, discharges into receiving drainage systems shall not have acid or basic pH levels. F. Sealed storage tanks shall be used to reduce turbidity and pH before discharge.

TABLE D.2.2.9.A CTB/CKD Soil Amendment BMPs		
Category of Action	**Specific Action**	**CTB/CKD Best Management Practices**
8. Chemical Treatment		A. Carbon dioxide sparging (dry ice pellets) may be used as the chemical treatment agent to reduce the water pH. B. Any means of water treatment to reduce pH will require an NPDES discharge permit from Ecology. Permit would only be granted after bench testing performed by an independent qualified party. C. Active mixing will cease if the residual retention water volume falls below the ability to treat and properly dispose of contact storm water. D. Discharge would only occur after the approval of Ecology, following bench testing and consultation with Ecology. E. All materials for chemical treatment will be on site and property stored, during all phases of CTB/CKD treatment.
9. Water Quality	Monitoring	A. Turbidity and pH will be monitored on a twice-daily basis, prior to operations and immediately upon ceasing operations, and these measurements will be recorded. Monitoring will also occur immediately after any storm event of ½ inch in 24 hours, or water migration to the retention pond(s), and the measurements recorded. If the pH approaches 8.0, monitoring frequency will increase. B. Turbidity and pH monitoring will occur in all treatment facilities, stormwater detention facilities, infiltration areas (if infiltration is used), and in all surface water areas adjacent to site where stormwater potentially discharges. Additional upstream surface water sites will be established to determine background levels of turbidity and pH. C. All water quality monitoring data will be conducted and evaluated by an independent, qualified party and conducted using professionally supportable test protocols and QA/QC procedures.
10. Reporting	Ecology and DPER	A. All water quality monitoring data will be included in weekly DPER TESC reports to DPER, and in weekly NPDES reports to Ecology. B. All work, testing, and monitoring associated with the application of CTB/CKD shall be observed by engineer. The engineer shall prepare and submit a report to the assigned DPER project inspector indicating BMPs were/were not being met. C. Copies of all reports and logs will be available on site during the soil and surface runoff treatment activities.

TABLE D.2.2.9.A CTB/CKD Soil Amendment BMPs		
Category of Action	**Specific Action**	**CTB/CKD Best Management Practices**
Other elements to consider:		
. Water Quality – Soils	Source Controls	A. There may be very small amounts of concrete washout produced onsite as a result of construction of erosion control measures during reclamation. Concrete washout, if any, would be retained in a lined enclosure of at least 6-ml visqueen or plastic sheeting, with no outlet. The washout retention enclosure would be isolated and separate from any CTB/CKD area runoff. Contents of the lined concrete washout enclosure will be removed from the site via a vactor truck for disposal in an approved off-site treatment or disposal facility in accordance with all federal, state, and local laws and regulations. Signed trip tickets, as proof of proper disposal, will be provided to Ecology and DPER.
. Water Quality – pH	Cover Measures	A. Areas amended with CTB/CKD for compaction after CTB/CKD addition will be covered with plastic or visqueen sheeting, or other impervious material by the end of each working day. B. Temporary cover will be maintained over all compacted areas amended with CTB/CKD until testing confirms that pH levels are stabilized to background measurements. [Note: Curing to avoid pH effects has no relationship to the rate at which material can be compacted in multiple lifts. Compaction will commence immediately after application and mixing, and multiple lifts will occur as quickly as each lift is compacted and ready to accept the next.] C. Should weather conditions prevent mixing, any unmixed CTB/CKD remaining on site will be enclosed in a sealed containment, such as portable silo, or removed from site.

Processing Requirements for Use of High pH Soil Amendments on Construction Sites[10]

Purpose

This section establishes procedures for implementing BMPs when using high pH soil amendments on construction sites. See Table D.2.2.9.A for a description of the BMPs. This section outlines an expedited review process and typical approval conditions that will allow contractors and builders to use soil amendments without impacting water quality. Additional BMPs may be required based upon site specific conditions that may warrant more protection. This policy is limited to those amendments, defined below, commonly known to add stability to sloppy soil conditions but which can alter water runoff quality.

[10] Excerpted from the King County *Stormwater Pollution Prevention Manual (SPPM)*, BMP Info Sheet #11

Authority: KCC 9.12.025 prohibits discharges of polluted or contaminated water into surface or storm water drainage systems. The purpose of this statute is to protect surface and ground water by regulating the discharge of potentially contaminated surface water. If soil amendments are proposed with an initial application, an environmental review is required, under SEPA, which assesses impacts, provides public input and mitigated conditions for its use.

King County Road Design and Construction Standards, Sections 4.04 and 4.05 also require an engineered design for use of a soil amendment on road surfaces or around drainage systems. The design may incorporate a thorough assessment of soil composition and laboratory analysis. The *Surface Water Design Manual* authorizes DPER to adopt BMPs for the control and protection of surface water. Currently, for all sites, the BMPs established in this policy are the minimum standards that shall be applied.

Procedure

An applicant may apply for use of soil amendments allowed under this policy anytime during the permit application review or after the permit has been issued and site construction is underway. After making a submittal to DPER, the applicant may receive approval conditions. Conditions may vary from site to site, but typically will include many of the BMPs included in this policy.

Applicants should identify any use of soil amendments as early in the process as possible to avoid delays in obtaining approval for use during the construction phase. If a site has known soil and water conditions that might make work during rainy periods difficult, they may want to plan to use soil amendments on their site. Obviously, if this issue is addressed at the permit review phase, implementation in the field can occur without delay. However, because of the potential risks of surface water pollution discharge and required treatment, an environmental assessment will be necessary before conditions for use can be established.

Limitations

This policy applies to the intended use of soil amendments in areas that will be covered by impervious surfaces. For areas not covered by impervious surfaces, additional reviews, study, and BMPs may be required. In addition, alterations to original approved use plans will require a resubmittal for approval. Approval for the use of the soil amendments in unincorporated King County can only occur by strictly following the procedures contained herein and not by any other approval obtained from DPER.

Submittal Requirements

To obtain approval for the use of soil amendments allowed under this policy, the applicant shall prepare a submittal package to DPER that includes the following:

- Letter to DPER requesting use of soil amendments at a construction site allowed under this policy.
- Document or letter attachment that identifies source of materials and description of mixing and laydown process, plan for disposal of treated contact water, sanitary sewer permits and/or BMPs, and special precautions proposed to prevent the contamination of surface or stormwater drainage systems, other than 'sealed' drainage systems.
- Site Plan: Show a site plan map which:
    1) Shows overall grading plan showing existing and proposed contours.
    2) Identifies sensitive areas and permanent or temporary drainage facilities.
    3) Identifies areas that soil amendment is planned.
    4) Shows depths of application and percent of amendment to be used.
    5) Shows location of special wheel wash facility.
    6) Shows location of collection and conveyance swales or pipes for contact water.
    7) Shows location of sealed storage/treatment tanks or temporary ponds (fully lined).

8) Identifies any discharge point from the site into natural drainage systems.

9) Includes soil log locations that identify seasonal high groundwater areas.

- Report and analysis of engineering mix design which includes depths of application and percent of amendment usage.
- For proposals that use CKD and CKD additive, provide analysis of source material for soluble contaminants. Include a description of fuel source.
- Monitoring criteria, including locations for pH and turbidity testing.
- Provide contingency plan should use of soil amendment and site and weather conditions result in polluted or contact water entering natural drainage systems.
- Provide contact information or water quality specialist assigned to monitor application of soil amendments and BMPs.

If the project is under construction, the applicant shall contact the DPER inspector assigned to the project to initiate a review for compliance with the BMPs and requirements herein. Otherwise contact the planner or engineer assigned to review the permit or land use application.

Review and Approval

Once the review has been completed, the applicant shall be notified by letter which stipulates the conditions of approval. Prior to authorizing the use of soil amendments at the site, the applicant shall provide a special restoration financial guarantee cash deposit in the amount as determined by the existing, established processes. Note: It remains the applicant/contractor's responsibility to comply with any other applicable state or federal regulations such as use of NIOSH respiratory protection, safety goggles, gloves and protective clothing whenever using hazardous materials.

Applicable Standards

Typically, all proposals using soil amendments in unincorporated King County shall have these conditions as standard requirements:

1. Prior to any application of CKD/CTB, the general contract shall hold a preconstruction meeting with the assigned DPER inspector at least 3 working days in advance.
2. CKD will not be permitted for use in areas adjacent to or in proximity to wetlands and streams areas. CTB may or may not be permitted in these areas.
3. Areas not covered by impervious surfaces:
    - CKD will not be permitted in areas that will not be covered by impervious surfaces.
    - If CTB is proposed in these areas, an analysis of whether or not the soil amendment will change the post-development runoff characteristics and the permanent stormwater facilities were sized appropriately shall be submitted for review. Use of CTB in areas not permanently covered by impervious surface may require re-sizing of the permanent stormwater facilities.
4. If CKD is proposed, the contractor shall provide mill certificates verifying the product composition. The contractor/developer must be prepared to follow BMPs during and after soil treatment and be prepared to treat runoff from the treatment area(s) immediately. All stormwater collection systems must be in place and all equipment (pH meters, dry ice, etc.) must be onsite.
5. Collection of stormwater (see BMP #5 in Table D.2.2.9.A):
    - Stormwater from the application area shall be kept separate from and prevented from comingling with uncontaminated stormwater.
    - During the application of CKD/CTB, stormwater runoff shall be collected in temporary collection systems and shall not be allowed to enter the permanent facilities. Permanent drainage systems

shall be capped to prevent contact stormwater from entering the inlets of the catch basins. Stormwater from the application area shall not be collected in the temporary/permanent detention ponds, even if the underlying soils are 'impermeable'.

6. Treatment: If necessary, pH adjustment shall be done in the collection tanks or temporary ponds and not in the permanent detention ponds.
7. Disposal options: The proposal to use CKD/CTB must contain a disposal plan that may include one or a combination of sanitary sewer or approved offsite disposal. Treated contact water may be discharged to the sanitary sewer if authorizations are obtained from the King County Industrial Waste Program (206-263-3000) and the local sewer district. All discharge conditions (e.g. pH, settleable solids) must be followed. If a sanitary sewer is not available at the site, contact water may be transported offsite to an approved site for disposal and proof of proper disposal must be submitted to King County. All authorizations for disposal shall be obtained prior to CKD/CTB application.
    - Infiltration: Depending on the site conditions, pH-adjusted stormwater may be infiltrated. Prior to infiltration, pH must be between 6.5 and 8.5.
    - Surface Water: Contact water from the application area shall not be discharged to surface waters, even if treatment has adjusted the pH.
8. Emergency backup plan: An emergency backup plan must be prepared and ready to implement to handle large quantities of stormwater.
9. Monitoring shall be conducted to determine that contact stormwater is not leaving the site. Offsite monitoring shall also be conducted to identify impacts to adjacent water bodies. Bonding may be required to cover mitigation of impacts and restoration.
10. A soils specialist will establish the mixing percentage for onsite soils. Soil amendments will never occur in excess of the ability of the onsite equipment and resources to meet all BMP requirements.
11. For sites one acre or larger, a National Pollutant Discharge Elimination System (NPDES) Construction Stormwater permit must be obtained from Ecology. NPDES permits and 'Stormwater Pollution Prevention Plans (SWPPPs) must be amended and the use of CKD/CTB must be approved by Ecology prior to application.

The contractor/developer shall comply will all federal, state, and local regulations. A health and safety plan may be required for the protection of King County inspectors.

Additional BMPs may be applicable depending on mix design, proximity of wetlands or streams (e.g. within 300 feet of class/type I and 100 feet or less for other types) and site conditions.

D.2.2.10 MAINTAIN PROTECTIVE BMPS

Pollutant protection measures shall be maintained to assure continued performance of their intended function. Reporting and documentation shall be kept current and made available to DPER as indicated.

Purpose: The purpose of maintaining protective BMPs is to provide effective pollutant protection when and where required by the plan and the project, and to provide timely and relevant project information.

When to Maintain: Protection measures shall be monitored per Section D.2.4.4 at a minimum, continuously during operation, and promptly maintained to fully functioning condition as necessary to assure continued performance of their intended function. Documentation shall be kept current per specific BMP requirements.

Measures to Use:

1. Maintain and repair all pollutant control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.
2. Maintain and repair storage locations for equipment and materials associated with BMP processes. Conduct materials disposal in compliance with County regulatory requirements.

3. As required, provide current reporting and performance documentation at an accessible location for the site inspector and other DPER staff.
4. Remove all temporary pollutant control BMPs prior to final construction approval, or within 30 days after achieving final site stabilization or after the temporary BMPs are no longer needed.

D.2.2.11 MANAGE THE PROJECT

SWPPP requirements shall be implemented and managed as part of the overall CSWPP plan. Concrete construction and its impacts are primary among pollutant concerns on site development projects. Fueling operations and materials containment of treatment chemicals and other project materials are also typical pollutant concerns. Operations that produce these and other pollutants are often conducted by subcontractors and their laborers, yet may require specific protective measures, documentation and reporting. Protective measures and BMPs need to be made available prior to construction and suitable oversight provided to assure inspection, monitoring and documentation requirements are met.

Projects shall assign a qualified CSWPP Supervisor (Section D.2.3.1) to be the primary contact for SWPPP and ESC issues and reporting, coordination with subcontractors and implementation of the CSWPP plan as a whole.

Measures to Use:

1. Phase development projects to the maximum degree practicable and take into account seasonal work limits.
2. Inspection and monitoring – Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Conduct site inspections and monitoring in accordance with the Construction Stormwater General Permit and King County requirements. Coordinate with subcontractors and laborers to assure the SWPPP measures are followed.
3. Documentation and reporting: – Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Document site inspections and monitoring in accordance with the Construction Stormwater General Permit, specific BMP conditions and King County requirements. Log sheets provided in Reference Section 8 may be used if appropriate. Follow reporting requirements and provide documentation as requested to DPER staff.
4. Maintaining an updated construction SWPPP – Maintain, update, and implement the SWPPP in accordance with the Construction Stormwater General Permit and King County requirements. Obtain approval for specific SWPPP measures (e.g., chemical treatments of stormwater) well in advance of need. Coordinate SWPPP plan updates with the site inspector (see Section D.2.4.1).

ESC MAINTENANCE REPORT

Performed By: _____
Date: _____
Project Name: _____
DPER Permit #: _____

Clearing Limits

Damage	OK ____	Problem
Visible	OK ____	Problem
Intrusions	OK ____	Problem
Other	OK ____	Problem

Mulch

Rills/Gullies	OK ____	Problem
Thickness	OK ____	Problem
Other	OK ____	Problem

Nets/Blankets

Rills/Gullies	OK ____	Problem
Ground Contact	OK ____	Problem
Other	OK ____	Problem

Plastic

Tears/Gaps	OK ____	Problem
Other	OK ____	Problem

Seeding

Percent Cover	OK ____	Problem
Rills/Gullies	OK ____	Problem
Mulch	OK ____	Problem
Other	OK ____	Problem

Sodding

Grass Health	OK ____	Problem
Rills/Gullies	OK ____	Problem
Other	OK ____	Problem

Perimeter Protection including Silt Fence

Damage	OK ____	Problem
Sediment Build-up	OK ____	Problem
Concentrated Flow	OK ____	Problem
Other	OK ____	Problem

Flow Control BMP protection

Damage	OK ____	Problem
Sedimentation	OK ____	Problem
Concentrated Flow	OK ____	Problem
Rills/Gullies	OK ____	Problem
Intrusions	OK ____	Problem
Other	OK ____	Problem

Brush Barrier

Damage	OK ____	Problem
Sediment Build-up	OK ____	Problem
Concentrated Flow	OK ____	Problem
Other	OK ____	Problem

Vegetated Strip

Damage	OK ____	Problem
Sediment Build-up	OK ____	Problem
Concentrated Flow	OK ____	Problem
Other	OK ____	Problem

Construction Entrance

Dimensions	OK ____	Problem
Sediment Tracking	OK ____	Problem
Vehicle Avoidance	OK ____	Problem
Other	OK ____	Problem

Wheel Wash
- Dimensions OK ____ Problem
- Sed buildup or tracking OK ____. Problem
- Other OK ____ Problem

Construction Road
- Stable Driving Surf. OK ____ Problem
- Vehicle Avoidance OK ____ Problem
- Other OK ____ Problem

Sediment Trap/Pond
- Sed. Accumulation OK ____ Problem
- Overtopping OK ____ Problem
- Inlet/Outlet Erosion OK ____ Problem
- Other OK ____ Problem

Catch Basin/Inlet Protection
- Sed. Accumulation OK ____ Problem
- Damage OK ____ Problem
- Clogged Filter OK ____ Problem
- Other OK ____ Problem

Interceptor Dike/Swale
- Damage OK ____ Problem
- Sed. Accumulation OK ____ Problem
- Overtopping OK ____ Problem
- Other OK ____ Problem

Pipe Slope Drain
- Damage OK ____ Problem
- Inlet/Outlet OK ____ Problem
- Secure Fittings OK ____ Problem
- Other OK ____ Problem

Ditches
- Damage OK ____ Problem
- Sed. Accumulation OK ____ Problem
- Overtopping OK ____ Problem
- Other OK ____ Problem

Outlet Protection
- Scour OK ____ Problem
- Other OK ____ Problem

Level Spreader
- Damage OK ____ Problem
- Concentrated Flow OK ____ Problem
- Rills/Gullies OK ____ Problem
- Sed. Accumulation OK ____ Problem
- Other OK ____ Problem

Dewatering Controls
- Sediment OK ____ Problem

Dust Control
- Palliative applied OK ____ Problem

Miscellaneous
- Wet Season Stockpile OK ____ Problem
- Other OK ____ Problem

Comments:

Actions Taken:

Problems Unresolved:

Pollution Prevention Team	**Completed by:** _____ **Title:** _____ **Date:** _____
Responsible Official:_____	Title:_____
Team Leader:_____	Office Phone:_____
	Cell Phone #:_____
	Pager #:_____
Responsibilities: _____ _____ _____	
(1)_____	Title:_____
	Office Phone:_____
	Pager #:_____
	Cell Phone:_____
Responsibilities: _____ _____ _____	
(2)_____	Title:_____
	Office Phone:_____
	Pager #:_____
	Cell Phone #:_____
Responsibilities: _____ _____ _____	

Employee Training	**Completed by:** _____ **Title:** _____ **Date:** _____		
Describe the annual training of employees on the SWPPP, addressing spill response, good housekeeping, and material management practices.			
Training Topics **1.) LINE WORKERS**	**Brief Description of Training Program/Materials (e.g., film, newsletter course)**	**Schedule for Training (list dates)**	**Attendees**
Spill Prevention and Response			
Good Housekeeping			
Material Management Practices			
2.) P2 TEAM:			
SWPPP Implementation			
Monitoring Procedures			

List of Significant Spills and Leaks

Completed by:_____

Title:_____

Date:_____

List all spills and leaks of toxic or hazardous pollutants that were significant but are not limited to, release of oil or hazardous substances in excess of reportable quantities. Although not required, we suggest you list spills and leaks of non-hazardous materials.

Date (month/day/year)	Location (as indicated on site map)	Description				Response Procedure		Preventive Measure Taken
		Type of Material	Quantity	Source, If Known	Reason for Spill/Leak	Amount of Material Recovered	Material No longer exposed to Stormwater (Yes/No)	

Potential Pollutant Source Identification	**Completed by:** _____ **Title:** _____ **Date:** _____

List all potential stormwater pollutants from materials handled, treated, or stored on-site.

Potential Stormwater Pollutant	Stormwater Pollutant Source	Likelihood of pollutant being present in your stormwater discharge. If yes, explain

Material Inventory

Completed by: _____

Title: _____

Date: _____

List materials handled, treated, stored, or disposed of at the project site that may potentially be exposed to precipitation or runoff.

Material	Purpose/Location	Quantity (Units) (indicate per/wk. or yr.) Used	Produced	Stored		Likelihood of contact with stormwater If Yes, describe reason		Past Spill or Leak Yes	No

Section 9.0 Attachments

(No Attachments)

Section 10.0 Attachments

STORM FACILITY MAINTENANCE CHECKLIST

PROPERTY:	Tukwila Elementary School
PROPERTY OWNER:	Tukwila School District
PROPERTY ADDRESS:	5939 South 149th Street, Tukwila, WA 98168
INSPECTION DATE:	
COMPLETED BY:	

The following items shall be inspected. Further detailed instructions for maintenance can be found in the Operations and Maintenance Manual provided in the Technical Information Report.

1. Catch Basins/Area Drains

COMPLETED	ITEM
	Clear of:
☐	1. Trash and debris
☐	2. Sediment
☐	3. Structural damage to frame and or top slab
☐	4. Cracks in basin walls or bottom
☐	5. Vegetation
☐	6. Chemicals or pollution
☐	7. Settlement/misalignment
	The following are in satisfactory working condition:
☐	8. Cover/metal grate lid (in place, free of obstructions)
☐	9. Cover locking mechanism (bolts are present and pose no difficulty in removal)
☐	10. Ladder (no missing or damaged rungs)

2. Conveyance Pipes

COMPLETED	ITEM
	Clear of:
☐	1. Trash and debris
☐	2. Sediment
☐	3. Vegetation

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Sediment	Sediment exceeds 60% of the depth from the bottom of the catch basin to the invert of the lowest pipe into or out of the catch basin or is within 6 inches of the invert of the lowest pipe into or out of the catch basin.	Sump of catch basin contains no sediment.
	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the catch basin by more than 10%.	No Trash or debris blocking or potentially blocking entrance to catch basin.
		Trash or debris in the catch basin that exceeds $^1/_3$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that catch basin is unsound.	Catch basin is sealed and is structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than $^1/_4$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the catch basin at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal Grates (Catch Basins)	Unsafe grate opening	Grate with opening wider than $^{7}/_{8}$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate. **Any open structure requires urgent maintenance**.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance**.	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 6 – CONVEYANCE PIPES AND DITCHES

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & debris accumulation	Accumulated sediment or debris that exceeds 20% of the diameter of the pipe.	Water flows freely through pipes.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.
Ditches	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment accumulation	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion damage to slopes	Any erosion observed on a ditch slope.	Slopes are not eroding.
	Rock lining out of place or missing (If Applicable)	One layer or less of rock exists above native soil area 5 square feet or more, any exposed native soil.	Replace rocks to design standards.