Technical Information Report

Conditional Use Permit Submittal

PREPARED FOR:

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

PROJECT:

Thorndyke Elementary School Addition
4415 South 150th Street
Tukwila, WA 98168
Parcel No. 004200-0280
AHBL No. 2180112.10

PREPARED BY:

Yi Yang, EIT
Project Engineer

REVIEWED BY:

Douglas G. Tapp, PE
Principal

Charlie Palmer, PE
Project Manager

DATE:

October 2018

Technical Information Report

Conditional Use Permit Submittal

PREPARED FOR:

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

PROJECT:

Thorndyke Elementary School Addition
4415 South 150th Street
Tukwila, WA 98168
Parcel No. 004200-0280
AHBL No. 2180112.10

PREPARED BY:

YI Yang, EIT
Project Engineer

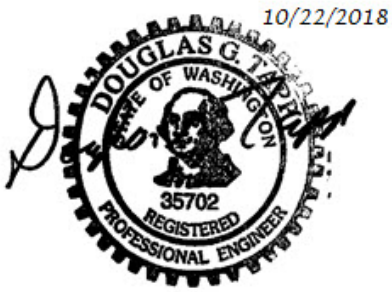
REVIEWED BY:

Douglas G. Tapp, PE
Principal

Charlie Palmer, PE
Project Manager

DATE:

October 2018



I hereby state that this Technical Information Report for the Thorndyke 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.

Table of Contents

1.0 Project Overview 1-1

1.1 Purpose and Scope 1-1
1.2 Existing Conditions 1-1
1.3 Post-Development Conditions 1-1

2.0 Conditions and Requirements Summary 2-1

2.1 Conditions of Approval 2-1
2.2 Core Requirements 2-1

2.2.1 CR 1 – Discharge at the Natural Location 2-1
2.2.2 CR 2 – Offsite Analysis 2-1
2.2.3 CR 3 – Flow Control 2-1
2.2.4 CR 4 – Conveyance System 2-1
2.2.5 CR 5 – Erosion and Sediment Control 2-1
2.2.6 CR 6 – Maintenance and Operations 2-1
2.2.7 CR 7 – Financial Guarantees and Liability 2-2
2.2.8 CR 8 – Water Quality 2-2
2.2.9 CR 9 – Flow Control BMPs 2-2

2.3 Special Requirements 2-2

2.3.1 SR 1 – Other Adopted Area-Specific Requirements 2-2
2.3.2 SR 2 – Floodplain/Floodway Delineation 2-2
2.3.3 SR 3 – Flood Protection Facilities 2-2
2.3.4 SR 4 – Source Controls 2-3
2.3.5 SR 5 – Oil Control 2-3

3.0 Offsite Analysis 3-1

3.1 Task 1 – Define and Map the Study Area 3-1
3.2 Task 2 – Review All Available Information on the Study Area 3-1
3.3 Task 3 – Field Inspect the Study Area (Level 1) 3-2
3.4 Task 4 – Describe the Drainage System, and its Existing and Predicted Drainage and Water Quality Problems 3-3
3.5 Task 5 – Mitigation of Existing or Potential Problems 3-5
3.6 Conclusion 3-5

4.0 Flow Control and Water Quality Facility Analysis and Design 4-1

4.1 Flow Control 4-1

4.1.1 Existing Site Hydrology (Part A) 4-1
4.1.2 Developed Site Hydrology (Part B) 4-1
4.1.3 Performance Standards (Part C) 4-1
4.1.4 Flow Control System (Part D) 4-2

5.0 Conveyance System Analysis and Design 5-1

6.0 Special Reports and Studies 6-1

6.1 Geotechnical Report 6-1
6.2 Critical Areas Report 6-1
6.3 Gilliam Creek Basin Stormwater Management Plan 6-1

7.0 Other Permits 7-1

8.0 CSWPPP Analysis and Design 8-1

8.1 ESC Plan Analysis and Design (Part A) 8-1

8.1.1 ESC Maintenance 8-1
8.1.2 ESC Supervisor 8-1
8.1.3 Documentation 8-2
8.1.4 Review Timing 8-2

8.2 Stormwater Pollution Prevention and Spill (SWPPS) Plan Design (Part B) 8-2

8.2.1 Pollution and Spill Prevention Source Controls and BMPs 8-2
8.2.2 Responsible Personnel and Contact Information 8-4
8.2.3 Pollution and Spill Prevention Worksheets 8-4
8.2.4 Disposal Methods 8-4

9.0 Bond Quantities, Facility Summaries, and Declaration of Covenant 9-1

10.0 Operations and Maintenance Plan 10-1

10.1 Facility Descriptions 10-1
10.2 Maintenance Tasks 10-1
10.3 Maintenance Requirements 10-1

11.0 Conclusion 11-1

Attachments

Section 1.0 Attachments

Exhibit 1-1 ..... TIR Worksheet
Exhibit 1-2 ..... Vicinity Map
Exhibit 1-3 ..... Existing Conditions Map
Exhibit 1-4 ..... Developed Conditions Map
Exhibit 1-5 ..... Soils Survey Map

Section 2.0 Attachments

(No Attachments)

Section 3.0 Attachments

Exhibit 3-1 ..... Vicinity Map
Exhibit 3-2 ..... Existing Conditions Map
Exhibit 3-3 ..... Offsite Analysis Map
Exhibit 3-4 ..... Offsite Analysis Drainage System Table
Exhibit 3-5 ..... Offsite Drainage Photos
Exhibit 3-6 ..... Floodplain Map
Exhibit 3-7 ..... Sensitive Areas Folio Map
Exhibit 3-8 ..... Drainage Basin Map
Exhibit 3-9 ..... Wetland Exhibit
Exhibit 3-10 ..... DOE Clean Water Act Section 303(d) Map

Section 4.0 Attachments

Exhibit 4-1 ..... MGSFlood Report
Exhibit 4-2 ..... Existing Hydrology Conditions
Exhibit 4-3 ..... Developed Hydrology Conditions

Section 5.0 Attachments

(To be included in Final Submittal)

Section 6.0 Attachments

Exhibit 6-1 ..... Geotechnical Report
Exhibit 6-2 ..... Critical Areas Report
Exhibit 6-3 ..... Gilliam Creek Basin Stormwater Management Plan

Section 7.0 Attachments

(No Attachments)

Section 8.0 Attachments

Exhibit 8-1 ..... ESC and SWPPS Measures
Exhibit 8-2 ..... ESC Maintenance Report
Exhibit 8-3 ..... Inspection Reports

Section 9.0 Attachments

(No Attachments)

Section 10.0 Attachments

Exhibit 10-1 ..... Storm Facility Maintenance Checklist
Exhibit 10-2 ..... Maintenance Requirements for Flow Control, Conveyance, and Water Quality Facilities

Section 1

Project Overview

1.0 Project Overview

1.1 Purpose and Scope

This report accompanies the civil engineering plans and documents for the Thorndyke Elementary School Addition project located on Parcel No. 004200-0280 in King County, Washington. The parcel is approximately 11.62 acres in total size and the area affected by redevelopment is approximately 0.34 acre. Refer to Exhibit 1-2 for a Vicinity Map.

The new improvements include construction of a two-classroom modular addition, new overflow parking, and an upgraded Early Learning play area. An underdrained soccer field in the southeast corner of the site is included as an alternative. Stormwater will be collected and routed to either the new detention facilities or the existing offsite bypass system. 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 playground, a school building, a concrete covered play area, and vegetated areas. Access to the site is from the South 150th Street right-of-way.

The site has roughly 8 feet of fall across the developed portion of the site, with the highest point along the northern boundary at roughly 226 feet, and the lowest point along the southern boundary at roughly 218 feet. The site also has a general slope from the northwest to the southeast. The existing 24-inch offsite bypass system provides stormwater collection for the east side of the parcel. Another existing main storm drain conveys stormwater that is generated in the west side of the parcel. These structures convey the stormwater to the control structure in the south side of the parcel that flows offsite. The area southwest of the school building sheet flows to catch basins located in the plaza and roundabout area; (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). A geotechnical report was prepared by GeoEngineers, Inc. on August 20, 2018, giving additional soil information (see Exhibit 6-1).

1.3 Post-Development Conditions

The project proposes to construct a new overflow parking area, a two-classroom modular addition, and an upgraded Early Learning play area. Improvements include demolition and replacement of the existing vegetated area to the west of the existing parking lot, adding the modular classrooms onto the existing school building, and expansion of the existing play area with new paving and equipment.

The project site area around the school is 0.34 acre, with 0.28 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 will be divided between the new detention facility and the existing storm system. Approximately 0.3 acre of the site will be discharged to the new flow control facility. The remainder of the site will be collected by the existing bypass system. Runoff generated on the surface of the soccer field will sheet flow to the area drains and then be retained by the field underdrain system. Refer to Exhibit 5-1 for clarification (to be provided with final submittal).

Stormwater improvements will include adding two detention facilities, 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. In the existing conditions, stormwater runoff sheet flows to catch basins that drain to an existing system that conveys the water south toward the existing play area and then east offsite. Flow continues southeasterly through the Gillian Basin before being discharged into Gillian Creek and into the Green River.

In the developed condition, part of the site will be collected into a new detention facility and the remainder will use the existing bypass system, meeting Core Requirement 9. The existing system ultimately discharges to the Green River approximately 3 miles 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 flow control structure located at the midpoint of the south boundary. This structure hydraulically connects to the existing storm system located in the northeast corner of the site area. In the developed condition, the storm runoff flows to a new detention facility, which drains to a water quality facility, then directly discharges to the outlet structure. Refer to Exhibit 3-3 for a map and description of the downstream drainage system.

2.2.3 CR 3 – Flow Control

The Thorndyke 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 an underground detention system to meet the flow control requirement. Another below grade flow control facility is proposed for the soccer field. 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 the 25-year peak flow. The design and calculations for the conveyance system will be included in Section 5.0 in 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 Public Schools. An Operations and Maintenance Plan is provided in Section 10.0.

2.2.7 CR 7 – Financial Guarantees and Liability

This project will provide a Drainage Facilities Restoration and Site Stabilization Financial Guarantee. A Bond Quantity worksheet is not required, per Washington Administrative Code, because 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 impervious area will be routed through a new water quality structure downstream of the detention facility. Above grade bioretention planters are proposed to provide maximum filtration to the roof drain of the new modular classrooms.

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 1.5 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. 53033C0959F, Panel 959 of 1725, was consulted for this project and did not show any floodplains on the project site. Refer to Exhibit 3-6 for the Foodplain 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 Thorndyke Elementary School is located on the southern side of South 150th Street between 43rd Place South and Kent Lane (Parcel 004200-0280). The parcel is surrounded by wooded area to the east and south and single-family residential developments to the north and west (see 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 parking lot and playground, concrete walkways, a rubber covered play area, and vegetated areas. Stormwater facilities include a wet vault providing flow control for the west side of the site; and an underground french drain system, which serves to provide water quality for the east side of the school. Two main conveyance pipes onsite flow southwesterly and southeasterly, converging at the south side of the existing school building. The downstream analysis begins at this point, where a manhole structure is located in the middle of the driveway.

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 0.25 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 (Exhibit 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 53033C0959F, 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 Qvrl, glacial recessional lacustrine deposits.
- 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).

- Other Critical Area Studies: Biologist has confirmed that no surface water or wetland areas were found within 300 feet of the site, including the two streams mapped on Tukwila iMap (Exhibit 3-7). Refer to the Critical Areas Report in Exhibit 6-2.

- Migrating River Studies: No rivers are located within 1 mile downstream of the project site classified as channel migration hazard areas.

- Other Offsite Analysis Reports: Gilliam Creek Basin Stormwater Management Plan prepared by Herrera Environmental Consultants, Inc. in 2001 (see Exhibit 6-3) also indicates that neither anadromous nor resident fish were observed within 1 mile of the site.

- 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 Duwamish 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.*

    - 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.*

    - 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.*

    - No existing/potential drainage problems were identified downstream of the project area.

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

    - 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 0.25 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. See the written description of the downstream drainage system given below.

The field inspection began at Element A, which is a Type 2 catch basin with vane grate, northeasterly to the existing parking lot. Water flows in Element A though a 12-inch CPEP and flows to Element B through a 24-inch CPEP. Refer to Element A in the enclosed documents for location, photos, and drainage systems table.

Element B is a Type 2 catch basin with vane grate in good condition that overflows through an 8-inch steel pipe and a 24-inch CPEP. The riser elevation of the corrugated pipe is set a few inches higher than the 8-inch pipe. Both pipes are installed shear valve for emergency flow. See Element B in the enclosed documents for location, photos, and drainage systems table.

Element C, a Type 2 catch basin, has water flowing from Element B through the 24-inch storm pipe, 8-inch pipe from the wet vault, plus the 24-inch CPEP of the bypass system running from the east side of the site. The catch basin is in good condition and exits the structure through a 24-inch CPEP. 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 24-inch CPEP flowing in and out. Refer to Element D in the enclosed documents for location, photos, and drainage systems table.

Element E is estimated 24-inch concrete pipe that daylights to the north tributary of Gilliam Creek. Refer to Element E in the enclosed documents for location, photos, and drainage systems table.

Elements F and G are observed at the southwest corner of the project site. Elements F and G are both open channel creeks and flow into an in-stream detention facility. The creeks then become a piped stream. See Elements F and G in the enclosed documents for location, photos, and drainage systems table.

Element H is the south tributary of Gilliam Creek. The stream flows northwesterly and crosses I-405 through culvert pipe(s), and then daylights as open channel again. See Element H in the enclosed documents for location, photos, and drainage systems table.

Element I is an underground, in-stream detention facility. Elements F and G converge at Element I, flowing toward the east underground. Refer to Element I in the enclosed documents for location, photos, and drainage systems table.

Element J is estimated Type 2 manhole with solid lid. The crew was not able to open the cover. See Element J in the enclosed documents for location, photos, and drainage systems table.

Water then travels east along the residential developments for approximately 0.25 mile through culvert pipe (Element K), and crosses Southcenter Boulevard near 51st Avenue South. Open stream is observed again at the intersection of 51st Avenue South and Southcenter Boulevard (Element L). See Elements K and L 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 piped conveyance system, creeks, and detention pond 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 Street southeasterly to the Type 2 catch basin south to the existing school building (Element C). Geometry and area of this TDA is 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 11.62 acres and the project site consists of approximately 0.33 acre of impervious surface and 0.01 acre of pervious surface.

The storm runoff from the west parking lot (approximately 0.52 acre) sheet flows to the area drains and is then routed to the wet vault. The playground and fire lane area (approximately 0.60 acre) at the east side of the school building sheet flow to catch basins connecting to the offsite bypass system. The vegetated area in the southwest corner of the site infiltrates through the French drains and eventually discharges to the 24-inch bypass pipe (see to Exhibit 4-2).

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, existing parking area, and new building addition roof area. A portion of the existing parking lot 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. The new detention facility is being added to contain the new/replaced impervious surfaces per the requirements in the *KCSWDM*. The storm system then connects to the existing storm system in the southwest portion of the site. Calculations are provided in Section 5.0. 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 parcel totals 11.62 acres. The proposed site includes 0.33 acre of impervious area, including new and replaced. The project falls under the Large 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. 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 new 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 followed by an underground stormwater chamber.

The total area for modeling consists of approximately 0.43 acre, of which 0.33 acre is new or replaced impervious surface, 0.01 acre is new vegetated area, and 0.09 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 new detention system will be located under the new parking area in the west of the site. Contributing areas to the system will consist of the new parking and flow through area. Runoff will sheet flow to the bioretention, and then infiltrate to the flow control facility.

The flow control facility will be sized for approximately 0.18 acre of new impervious area and approximately 0.09 acre of flow through area (totaling 0.27 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	0.34 ac Pervious	0.09 ac Impervious	Includes 0.09 ac of flow through area.
Developed Condition	0.01 ac Pervious	0.42 ac Impervious	Includes 0.18 ac of new parking, 0.05 ac of new roof area, 0.08 ac of play area, and 0.09 ac of flow through area.
Area Required for Flow Control	- -	0.27 ac Impervious	New parking and flow through area. Runoff generated by new roof, repaving, and play area will bypass.
Area Contributing to Flow Control	- -	0.27 ac Impervious	New parking and flow through area.
Total	**0.01 ac Pervious**	**0.42 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

GeoEngineers, Inc. performed a field investigation on August 20, 2018. See Exhibit 6-1 for the report.

6.2 Critical Areas Report

Grette Associates LLC performed a field investigation on October 3, 2018. See Exhibit 6-2 for the report.

6.3 Gilliam Creek Basin Stormwater Management Plan

Herrera Environmental Consultants, Inc. prepared this document for City of Tukwila on March 9, 2001. See Exhibit 6-3 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:

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

2. 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 System

The purpose of the detention system is to reduce the rate of stormwater runoff from developed portions of the property. Water can flow freely into the StormTech chambers, 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 detention facility 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.

Yi Yang, EIT
Project Engineer

YY/lsk

October 2018

Q:\2018\2180112\WORDPROC\Reports\20181019 Rpt (TIR) 2180112.10.docx

Section 1.0 Attachments

Exhibit 1-1 ..... TIR Worksheet
Exhibit 1-2 ..... Vicinity Map
Exhibit 1-3 ..... Existing Conditions Map
Exhibit 1-4 ..... Developed Conditions Map
Exhibit 1-5 ..... Soils Survey Map

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: Yi Yang
Company: AHBL, Inc.
Phone: 206-267-2425

Part 2 PROJECT LOCATION AND DESCRIPTION

Project Name: Thorndyke Elementary School
DPER Permit #: _____
Location Township: 23 N
Range: 04 E
Section: 15
Site Address: 4415 S 150th 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: _____

Exhibit 1-1

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)	
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	_____

Exhibit 1-1

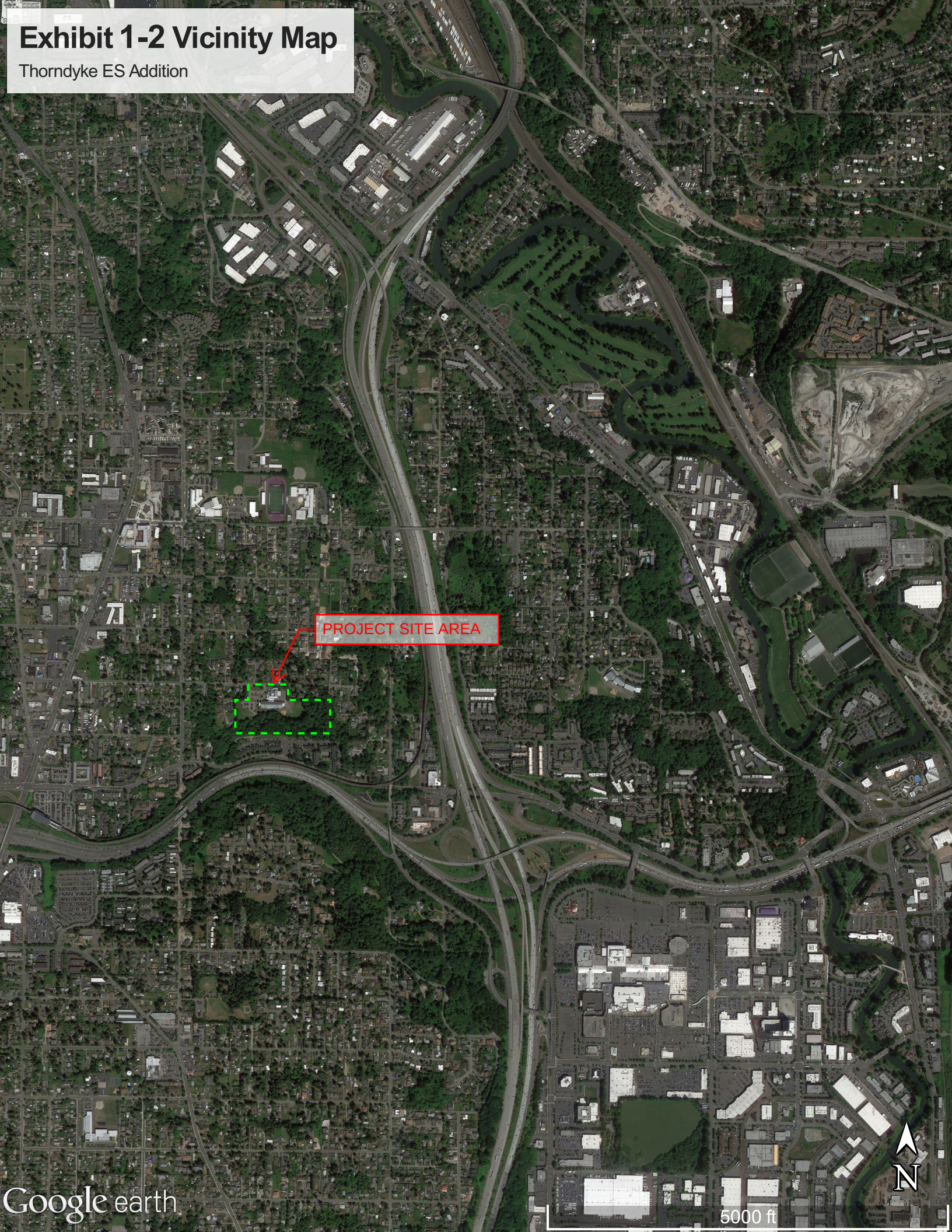
TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

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

Thorndyke ES Addition



Legend

Description	Quantity	Unit
Non-Target Impervious Area	3.09	ac
Project Site Area	0.34	ac

D (Ex.)

EXISTING POINT OF DISCHARGE

0 50 100 200

1" = 60 FEET

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

THORNDYKE ELEMENTARY SCHOOL ADDITION

EXISTING CONDITIONS MAP

EXHIBIT 1-3

Legend

Description	Quantity	Unit
Alt Bldg Addition Loc	0.05	ac
Flow Through	0.09	ac
Non-Impervious Area	0.01	ac
Non-Target Impervious Area	3.09	ac
Target Impervious Surface	0.33	ac

D (Ex.)

EXISTING POINT OF DISCHARGE

0 50 100 200

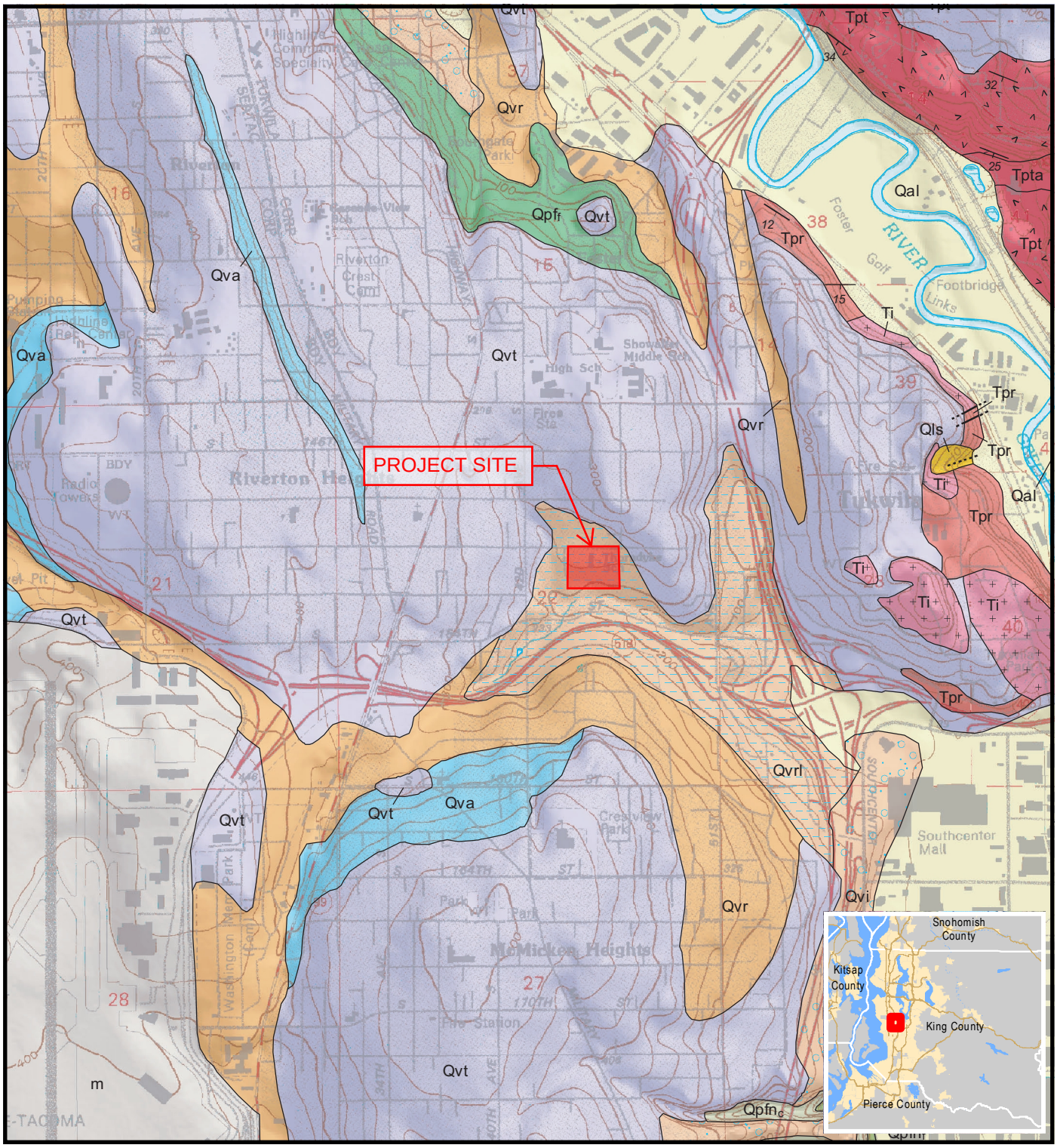
1" = 60 FEET

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

THORNDYKE ELEMENTARY SCHOOL ADDITION

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)

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

THORNDYKE ES ADDITION

SOILS SURVEY MAP

EXHIBIT 1-5

Section 2.0 Attachments

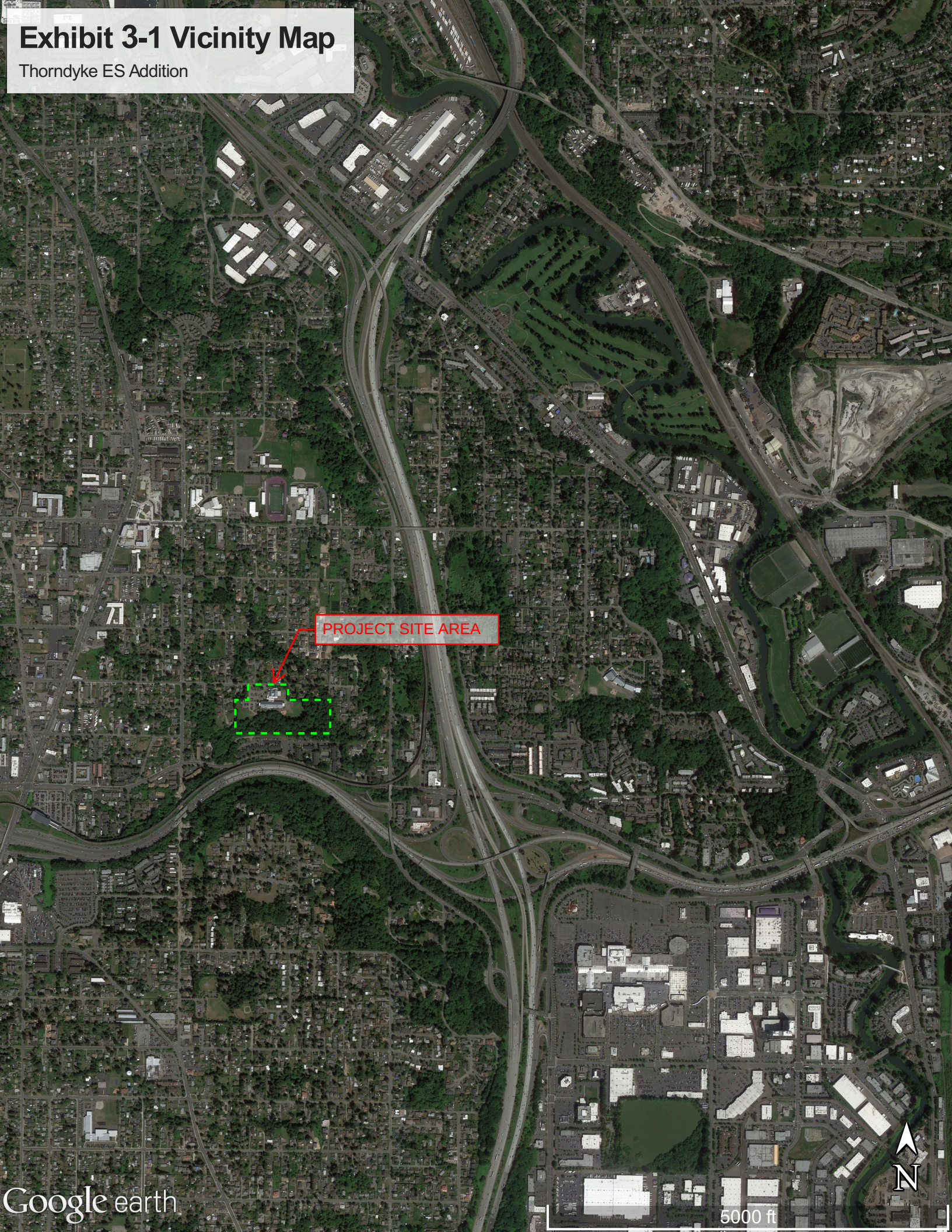
(No Attachments)

Section 3.0 Attachments

Exhibit 3-1 ..... Vicinity Map
Exhibit 3-2 ..... Existing Conditions Map
Exhibit 3-3 ..... Offsite Analysis Map
Exhibit 3-4 ..... Offsite Analysis Drainage System Table
Exhibit 3-5 ..... Offsite Drainage Photos
Exhibit 3-6 ..... Floodplain Map
Exhibit 3-7 ..... Sensitive Areas Folio Map
Exhibit 3-8 ..... Drainage Basin Map
Exhibit 3-9 ..... Wetland Exhibit
Exhibit 3-10 ..... DOE Clean Water Act Section 303(d) Map

Exhibit 3-1 Vicinity Map

Thorndyke ES Addition



Legend

Description	Quantity	Unit
Non-Target Impervious Area	3.09	ac
Project Site Area	0.34	ac

D (Ex.)

EXISTING POINT OF DISCHARGE

GRAPHIC SCALE

0 50 100 200

1" = 100 FEET

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

THORNDYKE ELEMENTARY SCHOOL ADDITION

EXISTING CONDITIONS MAP

EXHIBIT 3-2

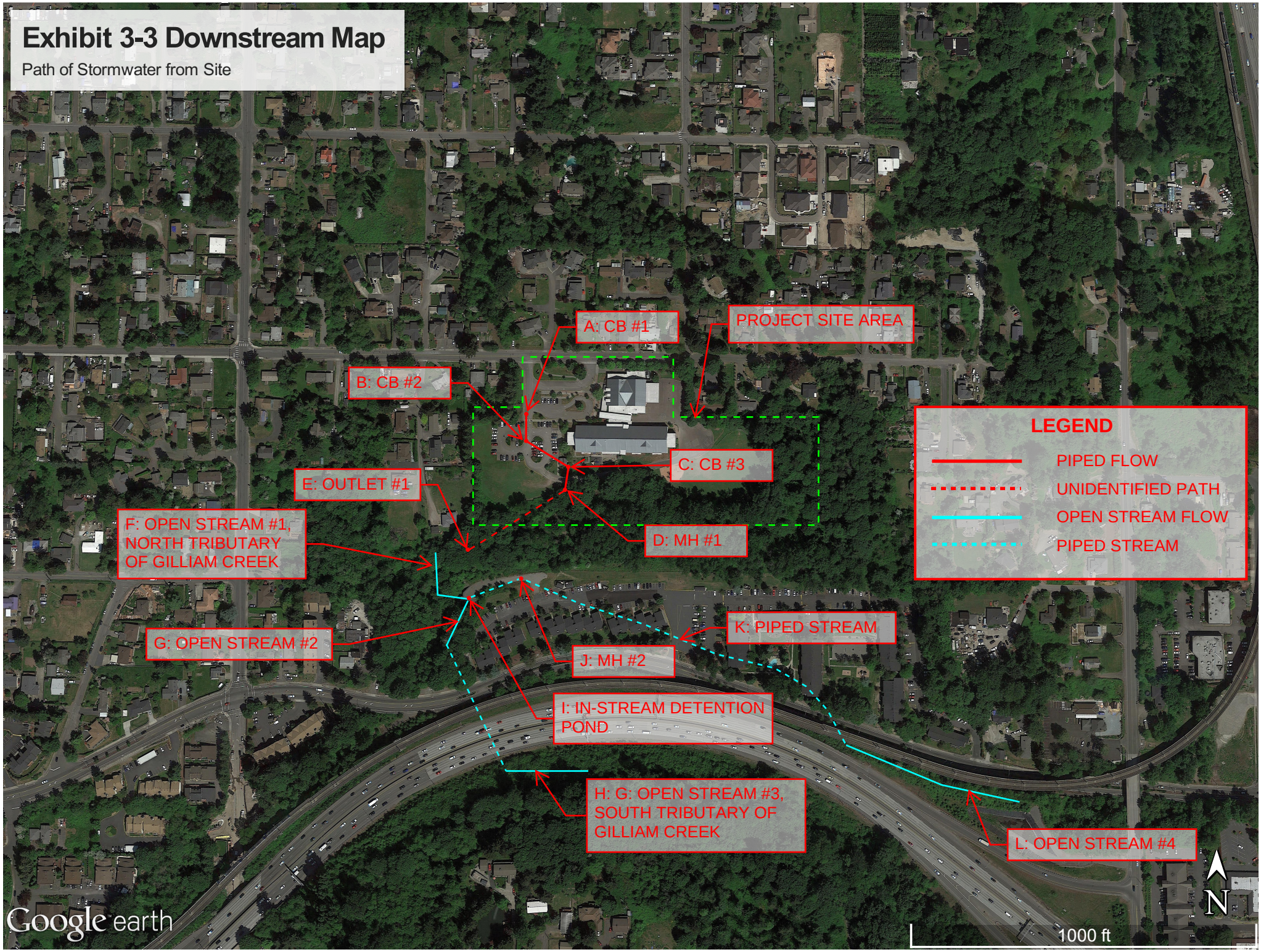


Exhibit 3-3 Downstream Map
Path of Stormwater from Site
A: CB #1
PROJECT SITE AREA
B: CB #2
C: CB #3
E: OUTLET #1
F: OPEN STREAM #1, NORTH TRIBUTARY OF GILLIAM CREEK
D: MH #1
LEGEND
PIPED FLOW
UNIDENTIFIED PATH
OPEN STREAM FLOW
PIPED STREAM
G: OPEN STREAM #2
K: PIPED STREAM
J: MH #2
I: IN-STREAM DETENTION POND
H: G: OPEN STREAM #3, SOUTH TRIBUTARY OF GILLIAM CREEK
L: OPEN STREAM #4
N
Google earth
1000 ft

Thorndyke Elementary School
Downstream Analysis

DATE: **8/23/2018**
BY: **Yi Yang**

DRAINAGE ELEMENT (SEE A-4)					
#	**DESCRIPTION**	**IN**	**OUT**	**PHOTOS**	**OBSERVATIONS OF FIELD INSPECTOR**
A	CB #1	12"	24"	A-1 A-2	
B	CB #2	24"	8" 24"	B-1 B-2	CONTROL STRUCTURE FOR WET VAULT SERVING WESTERN PARKING LOT
C	CB #3	8" 24" 36"	36"	C-1 C-2	FLOW FROM OFFSITE BYPASS SYSTEM CONVERGES
D	MH #1	36"	36"	D-1 D-2	
E	OUTLET #1	36"	36"		OUTLET AND PIPE LOCATED BEHIND THE FENCE. LOOKS IN GOOD CONDITION, NO SLOPE WASHOUT OBSERVED.
F	OPEN STREAM #1			E/F/G/I	BOG AREA AROUND STREAM HIGHLY SATURATED.
G	OPEN STREAM #2				BOG AREA AROUND STREAM HIGHLY SATURATED.
H	OPEN STREAM #3			N/A	
I	UNDERGROUND IN-STREAM DETIONTION POND			E/F/G/I	OPEN STREAM ENTERS STUCTURE AND RUNS UNDERNEATH RESIDENTIAL PROPERTY.
J	MH #2			J	NOT ABLE TO OPEN
K	PIPED STREAM			K	
L	OPEN STREAM #4			L	PIPED STREAM BECOMES OPEN CHANNEL AGAIN.

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

THORNDYKE ES ADDITION

TDA Drainage Table

EXHIBIT 3-4

A-1

A-2

B-1

B-2

C-1

C-2

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

THORNDYKE ELEMENTARY SCHOOL ADDITION

DOWNSTREAM ANALYSIS PHOTOS

DRAWN BY: Y. Yang | DATE: 8/23/2018 | JOB NO.: 2180112.10

EXHIBIT 3-5

D-1

D-2

E/F/G/I

J

K

L

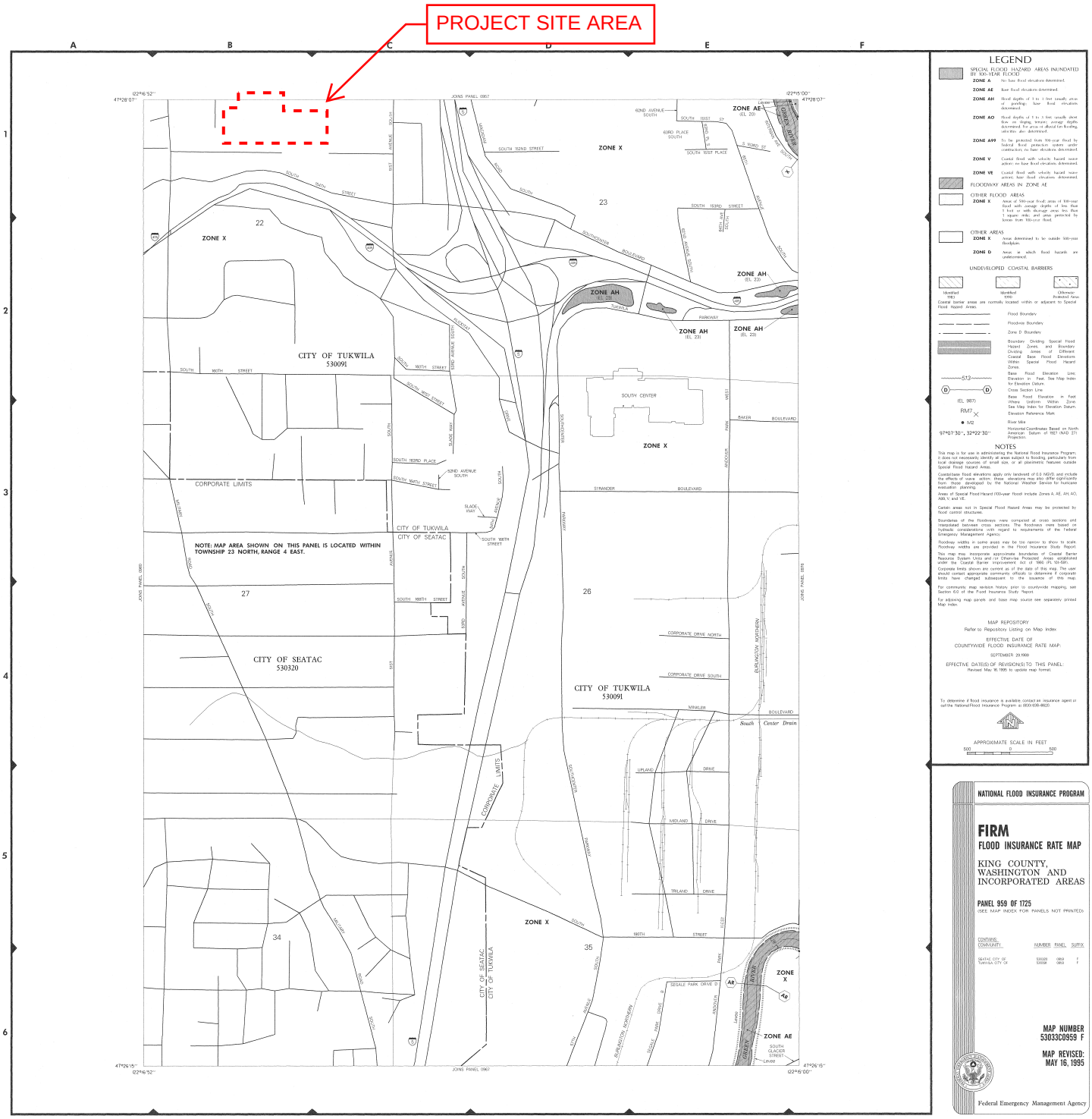
AHBL
1200 6th Avenue, Suite 1620
Seattle, WA 98101
206.267.2425 TEL 206.267.2429 FAX

THORNDYKE ELEMENTARY SCHOOL ADDITION

DOWNSTREAM ANALYSIS PHOTOS

DRAWN BY: Y. Yang | DATE: 8/23/2018 | JOB NO.: 2180112.10

EXHIBIT 3-5



AHBL

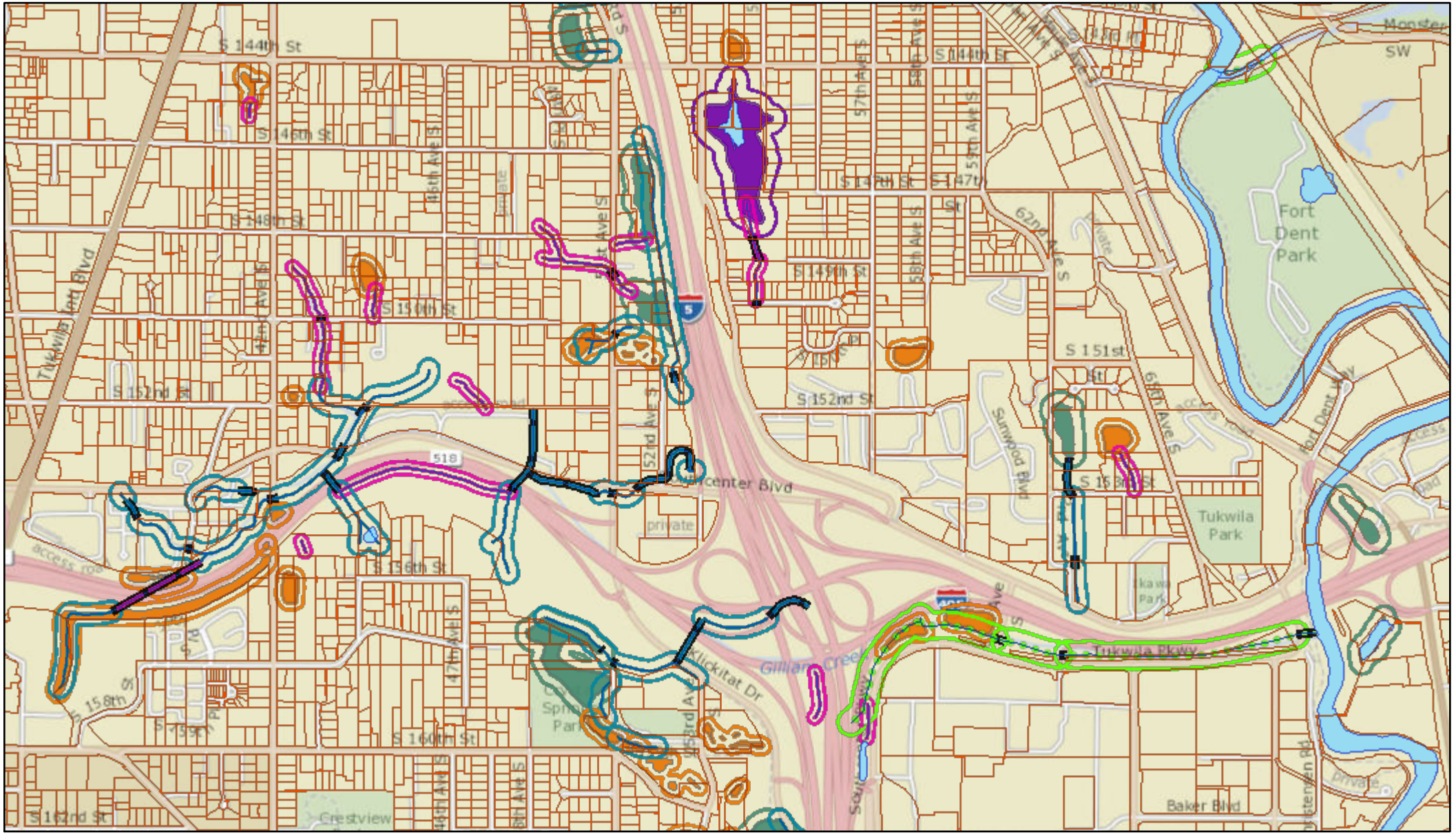
1200 6th Avenue
Suite 1620
Seattle, WA 98101
206.267.2425 TEL
206.267.2429 FAX

THORNDYKE ELEMENTARY SCHOOL ADDITION

Floodplain/Floodway (FEMA) Maps

EXHIBIT 3-6

Thorndyke 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

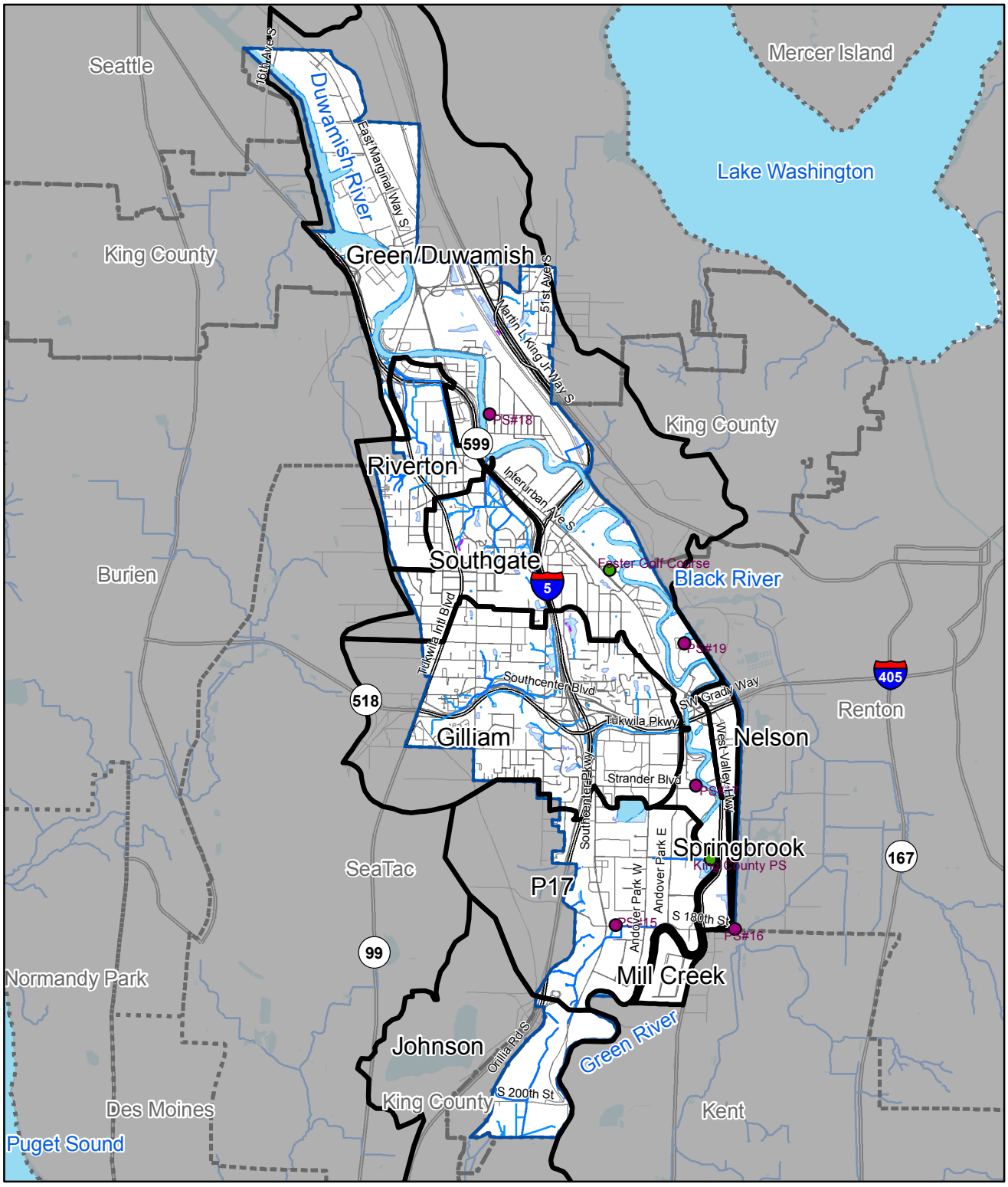


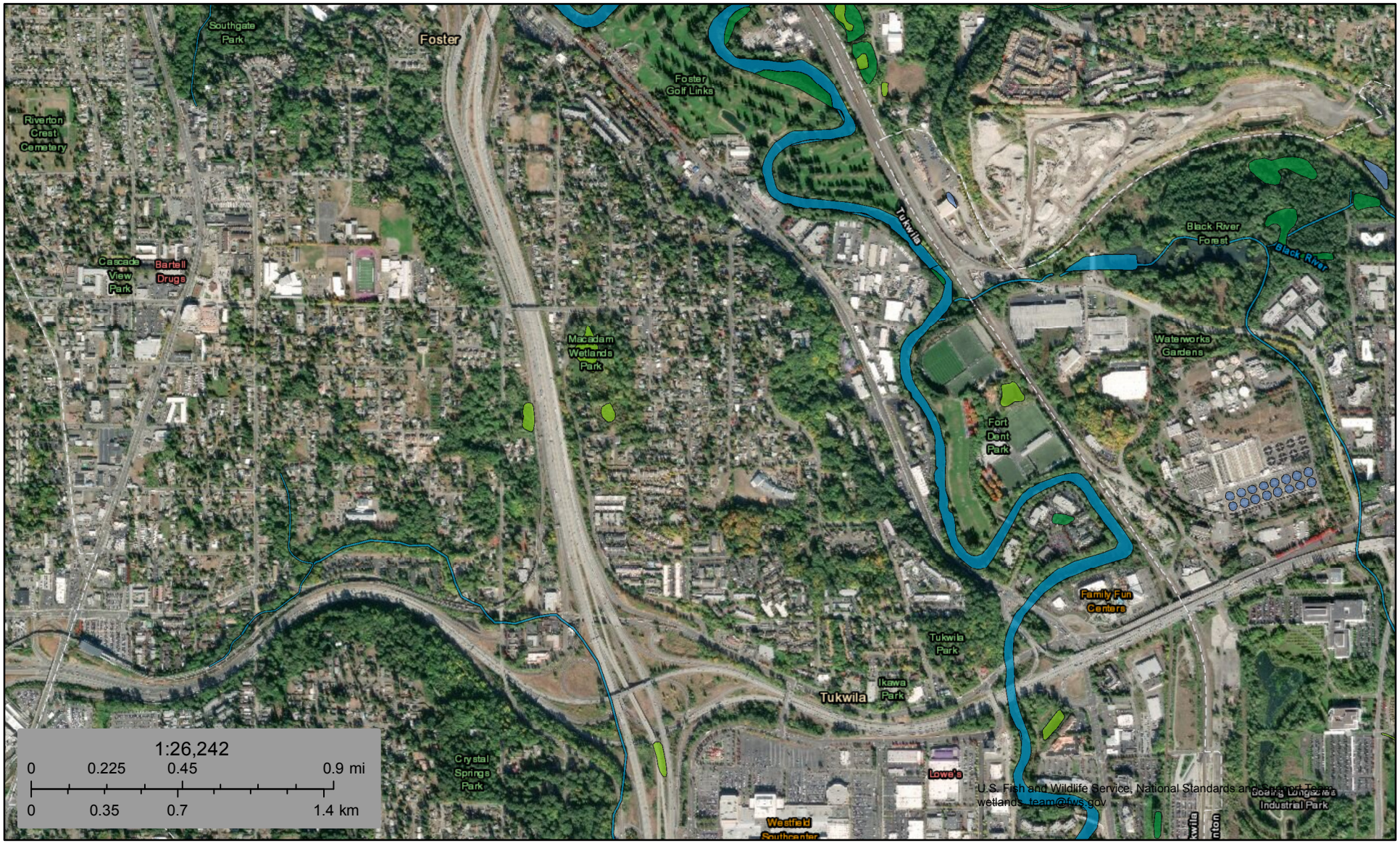
EXHIBIT 3-8

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

U.S. Fish and Wildlife Service

National Wetlands Inventory

Thorndyke Wetlands Inventory Map



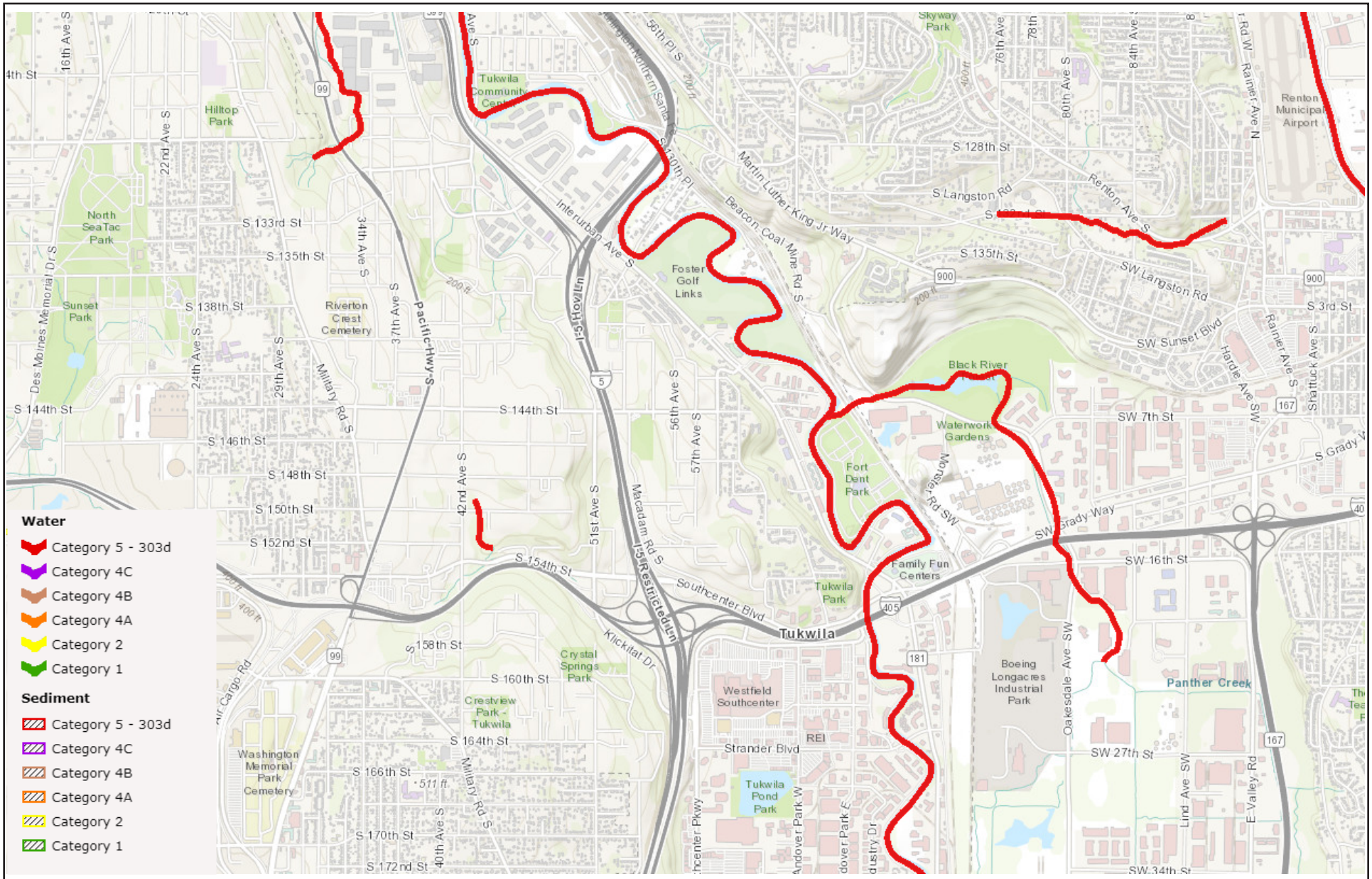
August 27, 2018

Wetlands

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

EXHIBIT 3-9

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



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

THORNDYKE ES ADDITION

303(d) List of Polluted Waters Map

EXHIBIT 3-10

Section 4.0 Attachments

Exhibit 4-1 ..... MGSFlood Report
Exhibit 4-2 ..... Existing Hydrology Conditions
Exhibit 4-3 ..... Developed Hydrology Conditions

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.43
Program License Number: 201710010
Project Simulation Performed on: 10/17/2018 4:12 PM
Report Generation Date: 10/17/2018 4:12 PM

Input File Name: Thorndyke.fld
Project Name: Thorndyke ES Addition
Analysis Title:
Comments: 20181001

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 : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 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)	0.430	0.419	← Area of new or replaced impervious surface
Area of Links that Include Precip/Evap (acres)	0.000	0.011	← Area of bioretention swale and above grade planter
Total (acres)	0.430	0.430	← Total area for modeling

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

---------- Subbasin : Site ----------

	-------Area (Acres) --------	
Till Forest	0.340	← Area of project site
Subbasin Total	0.340	

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

	-------Area (Acres) --------	
Impervious	0.090	← Area of flow through
Subbasin Total	0.090	

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

---------- Subbasin : Parking Lot ----------

	-------Area (Acres) --------
Impervious	0.180
Subbasin Total	0.180

---------- Subbasin : Modular Addition ----------

	-------Area (Acres) --------
Impervious	0.050
Subbasin Total	0.050

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

	-------Area (Acres) --------
Impervious	0.090
Subbasin Total	0.090

---------- Subbasin : Play Area & Repaving ----------

	-------Area (Acres) --------	
Impervious	0.099	← Play area = 0.08 acres; Repaving = 0.019 acres.
Subbasin Total	0.099	

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

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

Link Name: New Copy Lnk1
Link Type: Copy
Downstream Link: None

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

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

Link Name: Bioretention
Link Type: Bioretention Facility
Downstream Link Name: StormChamber

Base Elevation (ft)	:	224.00
Riser Crest Elevation (ft)	:	224.50
Storage Depth (ft)	:	0.50
Bottom Length (ft)	:	31.0
Bottom Width (ft)	:	10.0
Side Slopes (ft/ft)	:	L1= 3.00 L2= 3.00 W1= 3.00 W2= 3.00
Bottom Area (sq-ft)	:	310.
Area at Riser Crest El (sq-ft)	:	442.
(acres)	:	0.010
Volume at Riser Crest (cu-ft)	:	401.
(ac-ft)	:	0.009

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 : 225.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice Present in Under Drain

Orifice Control Elevation (ft) : 221.00
Orifice Diameter (in) : 6.000

Riser Geometry
Riser Structure Type : Rectangular
Riser Length (ft) : 2.00
Riser Width (ft) : 2.00
Common Length (ft) : 0.000
Riser Crest Elevation : 224.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

Link Name: StormChamber
Link Type: Structure
Downstream Link Name: New Copy Lnk2

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 219.00
Riser Crest Elevation (ft) : 222.00
Max Pond Elevation (ft) : 222.50
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 51.0
Pond Bottom Width (ft) : 17.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 867.
Area at Riser Crest El (sq-ft) : 867.
(acres) : 0.020
Volume at Riser Crest (cu-ft) : 2,601.
(ac-ft) : 0.060
Area at Max Elevation (sq-ft) : 867.
(acres) : 0.020
Vol at Max Elevation (cu-ft) : 3,121. ← Volume of flow control required
(ac-ft) : 0.072

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) : 0.000
Riser Crest Elevation : 222.00 ft

Hydraulic Structure Geometry

Number of Devices: 3

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 219.00
Diameter (in) : 0.25
Orientation : Horizontal
Elbow : No

---Device Number 2 ---
Device Type : Circular Orifice
Control Elevation (ft) : 220.65
Diameter (in) : 0.50
Orientation : Horizontal
Elbow : Yes

---Device Number 3 ---
Device Type : Circular Orifice

Control Elevation (ft) : 221.25
Diameter (in) : 0.50
Orientation : Horizontal
Elbow : Yes

Link Name: Planter
Link Type: Bioretention Facility
Downstream Link Name: New Copy Lnk2

Base Elevation (ft) : 221.00
Riser Crest Elevation (ft) : 224.00
Storage Depth (ft) : 3.00
Bottom Length (ft) : 56.0
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) : 168.
Area at Riser Crest El (sq-ft) : 168.
(acres) : 0.004
Volume at Riser Crest (cu-ft) : 620.
(ac-ft) : 0.014

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 : 222.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice Present in Under Drain
Orifice Control Elevation (ft) : 218.05
Orifice Diameter (in) : 6.000

Riser Geometry
Riser Structure Type : Rectangular
Riser Length (ft) : 2.00
Riser Width (ft) : 2.00
Common Length (ft) : 0.000
Riser Crest Elevation : 224.00 ft

Hydraulic Structure Geometry

Number of Devices: 0

Link Name: New Copy Lnk2
Link Type: Copy
Downstream Link: None

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

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

************ Subbasin: Site ************

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

Tr (yrs)	Flood Peak (cfs)
2-Year	5.569E-03
5-Year	9.495E-03

10-Year	1.302E-02
25-Year	1.742E-02
50-Year	2.335E-02
100-Year	2.554E-02
200-Year	3.840E-02

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

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

Tr (yrs)	Flood Peak (cfs)
2-Year	3.186E-02
5-Year	4.241E-02
10-Year	5.010E-02
25-Year	6.009E-02
50-Year	7.710E-02
100-Year	9.186E-02
200-Year	9.874E-02

********** Link: New Copy Lnk1 ********** Link Inflow Frequency Stats
Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	3.500E-02
5-Year	4.595E-02
10-Year	5.534E-02
25-Year	7.114E-02
50-Year	9.122E-02
100-Year	0.103
200-Year	0.109

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

********** **Subbasin: Parking Lot** **********

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

Tr (yrs)	Flood Peak (cfs)
2-Year	6.373E-02
5-Year	8.483E-02
10-Year	0.100
25-Year	0.120
50-Year	0.154
100-Year	0.184
200-Year	0.197

********** **Subbasin: Modular Addition** **********

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

Tr (yrs)	Flood Peak (cfs)
2-Year	0.000E+00
5-Year	0.000E+00
10-Year	0.000E+00
25-Year	0.000E+00
50-Year	0.000E+00
100-Year	0.000E+00
200-Year	0.000E+00

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

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

Tr (yrs)	Flood Peak (cfs)
2-Year	0.000E+00
5-Year	0.000E+00
10-Year	0.000E+00
25-Year	0.000E+00
50-Year	0.000E+00
100-Year	0.000E+00
200-Year	0.000E+00

********** **Subbasin: Play Area & Repaving** **********

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

Tr (yrs)	Flood Peak (cfs)
2-Year	0.000E+00
5-Year	0.000E+00
10-Year	0.000E+00
25-Year	0.000E+00
50-Year	0.000E+00
100-Year	0.000E+00
200-Year	0.000E+00

********** Link: Bioretention ********** Link Inflow Frequency Stats

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

Tr (yrs)	Flood Peak (cfs)
2-Year	6.373E-02
5-Year	8.483E-02
10-Year	0.100
25-Year	0.120
50-Year	0.154
100-Year	0.184
200-Year	0.197

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

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

Tr (yrs)	Flood Peak (cfs)
2-Year	5.018E-02
5-Year	7.421E-02
10-Year	8.980E-02
25-Year	0.102
50-Year	0.133
100-Year	0.167
200-Year	0.195

********** Link: Bioretention ********** Link WSEL Stats

WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	224.470
1.11-Year	224.504

1.25-Year	224.506
2.00-Year	224.512
3.33-Year	224.517
5-Year	224.519
10-Year	224.521
25-Year	224.523
50-Year	224.529
100-Year	224.535

********** Link: StormChamber ********** Link Inflow Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	5.018E-02
5-Year	7.421E-02
10-Year	8.980E-02
25-Year	0.102
50-Year	0.133
100-Year	0.167
200-Year	0.195

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

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.556E-03
5-Year	6.793E-03
10-Year	1.035E-02
25-Year	1.335E-02
50-Year	1.412E-02
100-Year	1.425E-02
200-Year	2.424E-02

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

WSEL Frequency Data(ft)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	220.143
1.11-Year	220.273
1.25-Year	220.445
2.00-Year	220.786
3.33-Year	220.989
5-Year	221.124
10-Year	221.387
25-Year	221.684
50-Year	221.779
100-Year	221.795

********** Link: Planter ********** Link Inflow Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.000E+00
5-Year	0.000E+00
10-Year	0.000E+00
25-Year	0.000E+00
50-Year	0.000E+00
100-Year	0.000E+00

200-Year	0.000E+00

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

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

Tr (yrs)	Flood Peak (cfs)
2-Year	1.950E-03
5-Year	2.477E-03
10-Year	3.144E-03
25-Year	3.861E-03
50-Year	4.286E-03
100-Year	4.755E-03
200-Year	5.474E-03

********** Link: Planter ********** Link WSEL Stats

WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	221.005
1.11-Year	221.005
1.25-Year	221.006
2.00-Year	221.008
3.33-Year	221.009
5-Year	221.010
10-Year	221.012
25-Year	221.015
50-Year	221.017
100-Year	221.018

********** Link: New Copy Lnk2 ********** Link Inflow Frequency Stats

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

Tr (yrs)	Flood Peak (cfs)
2-Year	4.738E-03
5-Year	6.793E-03
10-Year	1.044E-02
25-Year	1.370E-02
50-Year	1.436E-02
100-Year	1.453E-02
200-Year	2.474E-02

**********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	51.964
Subbasin: Flow Through	0.000
Link: New Copy Lnk1	0.000
Total:	51.964

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Parking Lot	0.000
Subbasin: Modular Addition	0.000
Subbasin: Flow Through	0.000

Subbasin: Play Area & Repaving 0.000
Link: Bioretention 0.000
Link: StormChamber 0.000
Link: Planter 0.000
Link: New Copy Lnk2 0.000
Total: 0.000

Total Predevelopment Recharge is Greater than Post Developed
Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.329 ac-ft/year, Post Developed: 0.000 ac-ft/year

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

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

Number of Links: 1

********** Link: New Copy Lnk1 **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 56.95
Inflow Volume Including PPT-Evap (ac-ft): 56.95
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): 56.95
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

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

Number of Links: 4

********** Link: Bioretention **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 70.97
Inflow Volume Including PPT-Evap (ac-ft): 73.90
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 71.65, 96.96%
Primary Outflow To Downstream System (ac-ft): 73.99
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 96.96%

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

Basic Wet Pond Volume (91% Exceedance): 732. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1098. cu-ft

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 73.99
Inflow Volume Including PPT-Evap (ac-ft): 73.99
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): 73.97
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

********** Link: Planter **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 0.00
Inflow Volume Including PPT-Evap (ac-ft): 1.71
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 1.71, 100.00%
Primary Outflow To Downstream System (ac-ft): 1.72

Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 100.00%

********** Link: New Copy Lnk2 **********

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 75.69
Inflow Volume Including PPT-Evap (ac-ft): 75.69
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): 75.69
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

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

Scenario Predeveloped Compliance Link: New Copy Lnk1
Scenario Postdeveloped Compliance Link: New Copy Lnk2

***** 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	3.500E-02	2-Year	4.738E-03
5-Year	4.595E-02	5-Year	6.793E-03
10-Year	5.534E-02	10-Year	1.044E-02
25-Year	7.114E-02	25-Year	1.370E-02
50-Year	9.122E-02	50-Year	1.436E-02
100-Year	0.103	100-Year	1.453E-02
200-Year	0.109	200-Year	2.474E-02

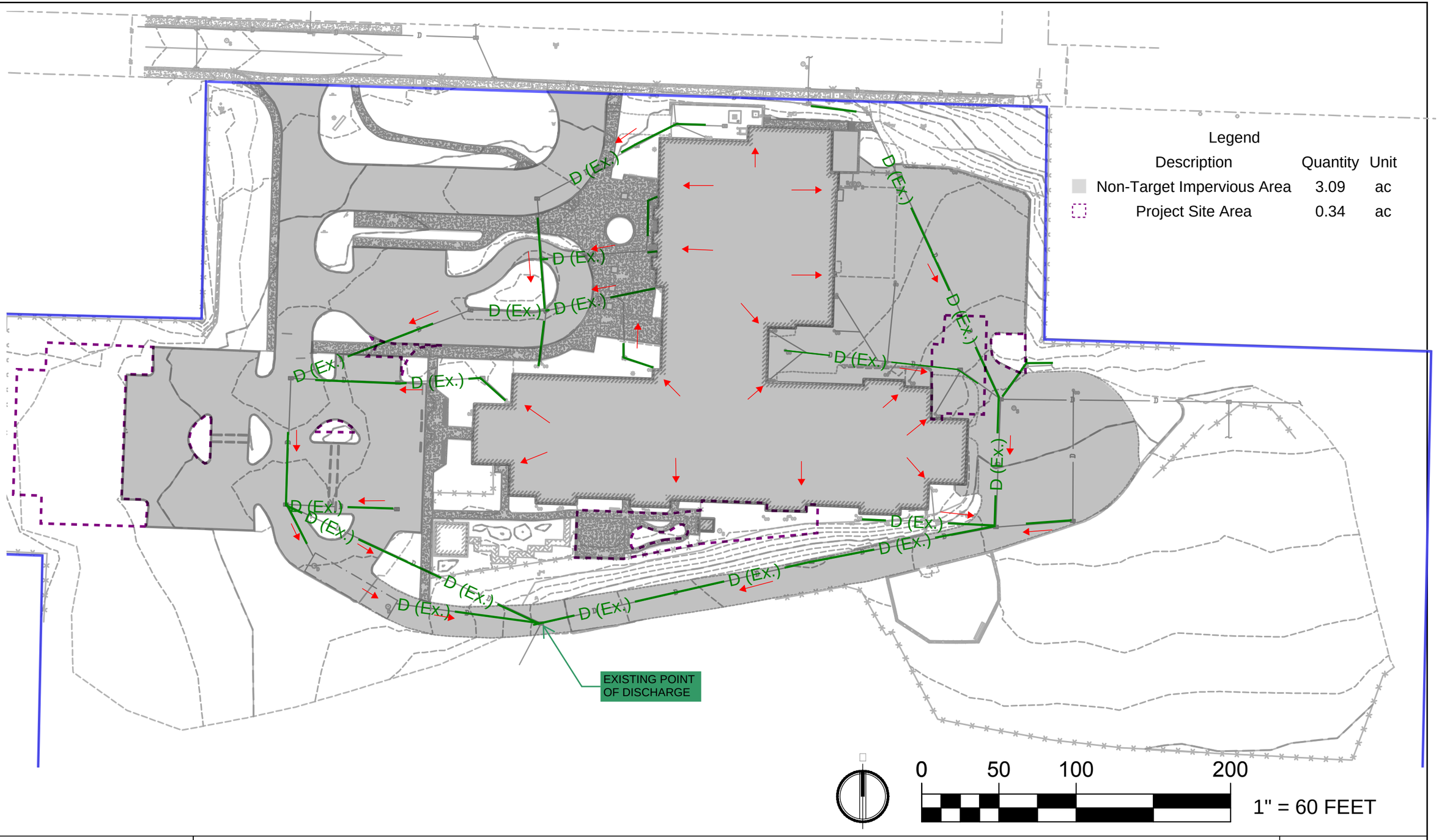
** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******
Excursion at Predeveloped 50%Q2 (Must be Less Than or Equal to 0%): -99.8% PASS
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than or Equal to 0%): -99.5% PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%): -92.3% 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%): -88.4% PASS
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%): -87.0% PASS

MEETS ALL LID DURATION DESIGN CRITERIA: PASS



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

THORNDYKE 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

THORNDYKE ELEMENTARY SCHOOL ADDITION

DEVELOPED CONDITIONS MAP

EXHIBIT 4-3

Section 5.0 Attachments

(To be included in Final Submittal)

Section 6.0 Attachments

Exhibit 6-1 ..... Geotechnical Report
Exhibit 6-2 ..... Critical Areas Report
Exhibit 6-3 ..... Gilliam Creek Basin Stormwater Management Plan

Geotechnical Engineering Services Report

Tukwila School District – Thorndyke Elementary School Improvements
Tukwila, Washington

for
Tukwila School District, No. 406

August 20, 2018

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Services Report

Tukwila School District – Thorndyke Elementary School Improvements
Tukwila, Washington

for
Tukwila School District, No. 406

August 20, 2018

GeoEngineers

1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

Geotechnical Engineering Services Report

Tukwila School District – Thorndyke Elementary School Improvements Tukwila, Washington

File No. 23537-001-00

August 20, 2018

Prepared for:

Tukwila School District, No. 406
c/o KMB Architects
906 Columbia Street SW, Suite 400
Olympia, Washington 98501

Attention: Jeffrey Feeney, PE

Prepared by:

GeoEngineers, Inc.
1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

CHRISTOPHER ROBERT NEWTON
STATE OF WASHINGTON
54300
REGISTERED
PROFESSIONAL ENGINEER
8/20/18

Christopher R. Newton, PE
Staff Geotechnical Engineer

MORGAN MCARTHUR
STATE OF WASHINGTON
46390
REGISTERED
PROFESSIONAL ENGINEER
8/20/18

Morgan McArthur, PE
Associate Geological Engineer

CRN:MM:tt

Table of Contents

INTRODUCTION AND PROJECT UNDERSTANDING **1**

SCOPE OF SERVICES **1**

SITE CONDITIONS **2**

Surface Conditions 2
Literature Review 3
Subsurface Conditions 3
    Subsurface Explorations and Laboratory Testing 3
    Soil and Groundwater Conditions 3

CONCLUSIONS AND RECOMMENDATIONS **4**

Primary Geotechnical Considerations 4
Seismic Design Considerations 4
Peak Ground Acceleration 5
Liquefaction 5
Lateral Spreading Potential 5
Surface Rupture Potential 5
Site Development and Earthwork 5
    General 5
    Clearing and Stripping 5
    Erosion and Sedimentation Control 6
Temporary Excavations 6
Groundwater Handling Considerations 7
Surface Drainage 7
Subgrade Preparation 7
Subgrade Protection and Wet Weather Considerations 7
Fill Materials 8
    Structural Fill 8
    Select Granular Fill 8
    Pipe Bedding 9
    Trench Backfill 9
    On-Site Soil 9
    Fill Placement and Compaction 9
    Foundation Support 10
Slab-on-Grade Floors 12
Retaining Walls and Below-Grade Structures 12
    Design Parameters 12
    Drainage 13
Stormwater Infiltration 13
    General 13
    Pilot Infiltration Tests 13
    Discussion and Additional Considerations 15
Pavement Recommendations 16
    Conventional Asphalt Concrete Pavements 16

Pervious Pavement 17
Pavement 17
Permeable Ballast 18
Treatment Layer 18
Subgrade Preparation 18
Protection, Maintenance and Icing 19
LIMITATIONS 19

LIST OF FIGURES

Figure 1. Vicinity Map
Figure 2. Site Plan
Figures 3 and 4. PIT Results

APPENDICES

Appendix A. Subsurface Explorations and Laboratory Testing
Figure A-1 – Key to Exploration Logs
Figures A-2 through A-6 – Logs of Test Pits
Figure A-7 – Sieve/Hydrometer Analysis Results
Figure A-8 – Sieve Analysis Results
Appendix B. Report Limitations and Guidelines for Use

INTRODUCTION AND PROJECT UNDERSTANDING

This report presents the results of our geotechnical engineering services for the proposed Thorndyke Elementary School Improvements project. The project site is located at 4415 South 150th Street in Tukwila, Washington as shown on the Vicinity Map, Figure 1. Our services have been completed in general accordance with our signed agreement dated July 24, 2018.

Our project understanding is based on a meeting with KMB Architects (project manager) and Rolluda Architects (project architect) on July 12, 2018 and a preliminary site plan provided during the meeting.

We understand that two new modular classrooms are proposed. Multiple locations are currently under consideration, including one near the northeast corner of site on the blacktop and one adjacent to the east side of the existing school building. We assume that foundations for the modular building(s) will consist of slab-on-grade with thickened edges or shallow spread footings with stem walls.

New parking lot areas and driveways are also planned. The overflow parking lot on the west side of campus is proposed to extend westward into the grass area toward the west perimeter of the property. The bus loop and campus entrance driveways will also be improved and/or reconfigured.

Other improvements include an upgraded playground structure and soccer field addition located near the southeast corner of the site. We understand that drainage improvements are planned for the area of the proposed soccer field.

We anticipate that stormwater infiltration or detention facilities will be included in site improvements. If planned, we assume stormwater infiltration and/or detention facilities will be designed and constructed in accordance with the 2016 King County Surface Water Design Manual (SWDM). We have currently assumed that potential infiltration and/or detention facilities may be located within the overflow parking lot addition on the west side of the site or in the grass area located in the southwest corner of the campus.

SCOPE OF SERVICES

The purpose of our services is to explore subsurface conditions to form a basis for developing geotechnical design and construction recommendations for the proposed improvements. Our specific scope of services included the following tasks:

1. Reviewing readily available published geologic data and our relevant in-house files for existing information on subsurface conditions in the project vicinity.
2. Visiting the project site to mark out exploration locations and contact the “One-Call” Utility Notification Center, as required by Washington State law. We also subcontracted a private utility locator.
3. Exploring subsurface conditions within the project area by advancing five test pits using subcontracted rubber-tire backhoe equipment and operator. The test pits were excavated to depths between about 8 and 11 feet below ground surface (bgs).
4. Conducting two small-scale pilot infiltration tests (PIT) near or within areas of proposed improvements.
5. Conducting geotechnical laboratory testing on selected soil samples.

6. Providing geotechnical seismic design information in accordance with 2015 International Building Code (IBC) criteria and discuss our opinion on the potential for surface rupture, liquefaction and lateral spreading at the site. We did not complete a quantitative liquefaction and lateral spreading analysis for this study.
7. Providing recommendations for site preparation and earthwork. We discuss temporary erosion and sedimentation controls, temporary and permanent cut slopes, fill placement and compaction requirements, wet weather considerations, groundwater handling and site drainage.
8. Providing recommendations for shallow spread footing design, including foundation bearing surface preparation, allowable soil bearing pressure, lateral resistance values and estimates of settlement.
9. Providing design considerations for slab-on-grade design, including subgrade preparation, modulus of subgrade reaction and capillary break thickness and materials.
10. Providing recommended active, passive and at-rest lateral earth pressures for retaining walls. We also provide recommendations for seismic surcharge pressures and drainage criteria.
11. Summarizing the results of our PITs and provide recommended long-term design infiltration rates for the tested locations. We also include a summary of the testing procedure and data collected. We also discuss our opinion for the need of a groundwater mounding analysis based on our observations of subsurface conditions.
12. Providing layer thickness recommendations for asphalt concrete pavement (ACP) and pervious pavement design sections, including subgrade preparation. We include typical pavement sections for heavy and light traffic areas based on our experience.

SITE CONDITIONS

Surface Conditions

The site is bounded by South 150th Street to the north and to the south by a slope with undeveloped, forested land that grades downward to the south. Residential properties bound the campus to the west and the east side is bounded by residential properties and undeveloped, forested land.

The existing school building is located in the central part of the campus. Other existing development features include asphalt paved driveways, parking lots and blacktop areas, sidewalks, landscaping, playground areas and grass fields.

Site topography is generally flat across the site with elevation differences up to about 3 to 4 feet. An asphalt paved access driveway running along the south side of the school building gently slopes downward from the southwest corner of the school building toward the southeast corner. The site also gently grades downward toward the southeast corner of the campus where the grass soccer field is located.

During our explorations, we observed a series of cracks along the southern edge of the asphalt paved access driveway running along south side of the school building next to the existing chain-link fence. The cracks were located just west of the playground and grass soccer field located in the southeast corner of the campus. The cracks were generally oriented parallel with the direction of the driveway and the cracks were less than about ½ to 1 inch in width. We observed a steep slope just on the other side of the chain-link fence in this area. The cracks could be a sign of minor slope movement or slope instability. A slope

reconnaissance was outside the scope of this project, and we understand improvements are not planned in this area. However, we are available to provide assistance if the school district is interested in an evaluation of this steep slope area.

Literature Review

The geologic information we reviewed in the project vicinity includes the *Geologic Map of the Des Moines 7.5' Quadrangle, King County, Washington* (Booth and Waldron 2004). Glacial soil deposits underlie the site and surrounding areas. These deposits are the result of glaciations that occurred during the Vashon Stade of the Fraser Glaciation, approximately 10,000 to 15,000 years ago. Surface soils at the site are primarily mapped as glacial recessional lacustrine deposits (Q_{vrl}). During ice recession, the recessional lacustrine deposits were deposited in small glacial lakes and are described to consist of fine sand, silt and clay. Recessional glacial deposits have not been glacially overridden and are, therefore, typically less dense than other glacial deposits, such as glacial till and advance outwash. Also mapped within the project vicinity is glacial till (Q_{vt}). Glacial till is described as a dense, compact mixture of sand, silt and gravel deposited by a glacier.

Subsurface Conditions

Subsurface Explorations and Laboratory Testing

We explored subsurface conditions at the site by excavating five test pits (TP-1 [PIT-1] through TP-5) at the approximate locations shown on the attached Site Plan, Figure 2. A description of our subsurface exploration program and summary exploration logs are provided in Appendix A. Two small-scale PITs were completed in test pits TP-1 (PIT-1) and TP-3 (PIT-2). The test results and methodology for the PITs are discussed in further detail in the "Stormwater Infiltration" section of this report.

Selected samples collected from our test pits were tested in our laboratory to confirm field classifications and to evaluate pertinent engineering properties. Our laboratory testing program included grain-size analyses and moisture content determinations. A summary of our laboratory testing program and the test results are provided in Appendix A.

Soil and Groundwater Conditions

In our explorations, we typically observed about 2 inches of grass sod. Beneath the sod, we generally observed sand with silt and variable gravel content to silty sand with variable gravel and cobbles content in a medium dense to very dense condition. We also observed silt with sand, occasional gravel and stratified sandy silt and clay with occasional gravel in a medium stiff to stiff condition. These materials extended to a depth of about ¾ to 10½ feet bgs in explorations TP-1 (PIT-1), TP-3 (PIT-2) and TP-5. We interpret these materials to be fill. Fill was observed to the full depths explored in TP-2 and TP-4. We observed an approximate 3-inch thick layer of hot-mix asphalt within the fill at about 1½ feet bgs in TP-1 (PIT-1). We also observed an approximate 1-foot layer of silt with organics and occasional sand and gravel in a medium stiff condition at about 5 feet bgs in TP-2.

Underlying the fill in TP-1 (PIT-1) and TP-5, we observed laminated silt and clay with occasional gravel and silt with variable sand content in a stiff to very stiff condition, which we interpret to be recessional lacustrine deposits, extending to the full depths explored.

Underlying the fill in TP-3 (PIT-2), we observed silty sand with gravel and occasional cobbles in a very dense condition, which we interpret to be glacial till, extending to the full depths explored.

We did not observe the regional groundwater table in our explorations. We did, however, observe slow groundwater seepage (less than 1 gallon per minute) in exploration TP-2 at about 9 feet bgs. We also observed wet soil conditions at about 7 feet bgs to the termination depth in TP-4 and from about 5 to 6 feet bgs in TP-5. We interpret the seepage and/or wet soil conditions to be perched groundwater. Though not observed in explorations TP-1 (PIT-1) and TP-3 (PIT-2), we anticipate that perched groundwater could be present depending on rainfall amounts, irrigation activities and other factors. We anticipate that perched groundwater levels will generally be highest during the wet season, typically October through May.

CONCLUSIONS AND RECOMMENDATIONS

Primary Geotechnical Considerations

Based on our understanding of the project, the explorations performed for this study and our experience, it is our opinion that the proposed improvements can be designed and constructed generally as envisioned with regard to geotechnical considerations. A summary of the primary geotechnical considerations for the project is provided below and is followed by our detailed recommendations.

- We did not identify soils that we interpret to be prone to significant liquefaction in our explorations, and in our opinion the risk of liquefaction occurring at this site is low.
- Proposed structures at the site can be supported using shallow foundations and slabs-on-grade, provided that the foundation bearing surfaces are prepared as recommended. We do not anticipate that significant overexcavation will be required, unless isolated areas of loose, or otherwise unsuitable areas are encountered near foundation grade.
- Based on our field testing and observations, the infiltration capacity of the observed site soils is low.
- Soils observed at the site contain a significant quantity of fines, and, therefore, could be difficult or impossible to work with when wet or become easily disturbed if exposed to wet weather. Depending on the intended use of the material and the moisture/weather conditions, it may be difficult to re-use on-site soils as structural fill.

Seismic Design Considerations

Based on subsurface conditions encountered in our explorations and our understanding of the geologic conditions in the site vicinity, the site may be characterized as Class D in accordance with the 2015 International Building Code (IBC) Design Manual. Seismic design parameters are provided in Table 1, below.

TABLE 1. 2015 IBC SEISMIC DESIGN CRITERIA

Site Coefficient	Site Factor	MCE[1] Spectral Response	Design Spectral Response[2]
S_s = 1.477g	F_a = 1.0	S_{MS} = 1.477g	S_{DS} = 0.985g
S_1 = 0.552g	F_v = 1.5	S_{M1} = 0.828g	S_{D1} = 0.552g

Notes:

[1] MCE = Maximum Considered Earthquake

[2] Design spectral response = 2/3 * MCE response

Peak Ground Acceleration

The peak ground acceleration (PGA) is used in seismic analyses such as liquefaction, lateral spreading, and seismic slope stability as well as assessing seismic surcharge loads for retaining walls. Based on our understanding of site conditions, we recommend using a PGA equal to 0.611g for the project site as determined in accordance with Section 11.8.3 of American Society of Civil Engineers (ASCE) Standard 7-10.

Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in development of excess pore pressures in loose, saturated soils and subsequent loss of strength in the deposit of soil so affected. In general, soils that are susceptible to liquefaction include loose to medium dense sands to silty sands that are below the water table. The *Liquefaction Susceptibility Map of King County, Washington* (Palmer, et al. 2004) indicates the site soils have a "very low" liquefaction potential. Based on observations and experience, we concur that the potential for liquefaction at the site is very low.

Lateral Spreading Potential

Lateral spreading related to seismic activity typically involves lateral displacement of large, surficial blocks of non-liquefied soil when a layer of underlying soil loses strength during seismic shaking. Lateral spreading usually develops in areas where sloping ground or large grade changes (including retaining walls) are present. Based on our understanding of the liquefaction risk at the site and the proposed improvements it is our opinion that the risk of lateral spreading is low.

Surface Rupture Potential

According to the Washington State Department of Natural Resources Interactive Natural Hazards Map (accessed August 3, 2018), there are no mapped faults within about 1 mile of the site. Based on the proximity of the site to the nearest mapped fault, it is our opinion the risk for surface rupture at this site is low.

Site Development and Earthwork

General

We anticipate that site development and earthwork will include the removal of asphalt pavement in areas of proposed improvements, excavating for shallow foundations, utilities and other improvements, establishing subgrades for foundations and roadways and placing and compacting fill and backfill materials. We expect that site grading and earthwork can be accomplished with conventional earthmoving equipment. The following sections provide specific recommendations for site development and earthwork.

Clearing and Stripping

We anticipate that clearing and stripping depths at the site will typically be on the order of about 6 to 10 inches to remove sod and associated root network at the surface. However, it is likely that greater stripping depths will be required in areas of heavier vegetation, lower lying areas or in areas containing trees.

During stripping operations excessive disturbance of surficial soils may occur, especially if left exposed to wet conditions. Disturbed soils may require additional remediation during construction and grading.

We encountered cobbles in our explorations, and while not observed, boulders can also be present in glacial deposits in the area. The contractor should be prepared to remove boulders and cobbles, if encountered during grading or excavation. Boulders may be removed from the site or used in landscape areas. Voids caused by boulder removal should be backfilled with structural fill.

Erosion and Sedimentation Control

Erosion and sedimentation rates and quantities can be influenced by construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an Erosion and Sedimentation Control Plan will reduce impacts to the project where erosion-prone areas are present. The plan should be designed in accordance with applicable county and/or state standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure;
- Re-vegetating or mulching denuded areas;
- Directing runoff away from exposed soils;
- Reducing the length and steepness of slopes with exposed soils;
- Decreasing runoff velocities;
- Preparing drainage ways and outlets to handle concentrated or increased runoff;
- Confining sediment to the project site;
- Inspecting and maintaining control measures frequently.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established, and the site is stabilized, site monitoring may be required by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan. Where sloped areas are present, some sloughing and raveling of exposed or disturbed soil on slopes should be expected. We recommend that disturbed soil be restored promptly so that surface runoff does not become channeled.

Temporary Excavations

Excavations deeper than 4 feet must be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes at this site should be inclined no steeper than about 1½H to 1V (horizontal to vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one-

half the depth of the cut away from the top of the slope and that seepage is not present on the slope face. Flatter cut slopes will be necessary where seepage occurs or if surcharge loads are anticipated. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

Groundwater Handling Considerations

Based on our understanding of the proposed site improvements we do not anticipate that the regional groundwater table will be encountered during excavations at the site.

Perched groundwater was observed in explorations TP-2, TP-4 and TP-5 and also is likely to be present in other areas at the site. The interface between the fill and recessional lacustrine deposits and contacts between more permeable and less permeable zones within the glacial soils are likely locations for accumulation of perched groundwater. Groundwater handling needs will typically be lower during the summer and early fall months. We anticipate that shallow perched groundwater can be handled adequately with sumps, pumps, and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered.

Surface Drainage

Surface water from roof downspouts, driveways and landscape areas should be collected and controlled. Curbs or other appropriate measures such as sloping pavements, sidewalks and landscape areas should be used to direct surface flow away from buildings, erosion sensitive areas and from behind retaining structures. Roof and catchment drains should not be connected to wall or foundation drains.

Subgrade Preparation

Subgrades that will support structures and roadways should be thoroughly compacted to a uniformly firm and unyielding condition on completion of stripping and before placing structural fill. We recommend that subgrades for structures and roadways be evaluated, as appropriate, to identify areas of yielding or soft soil. Probing with a steel probe rod or proof-rolling with a heavy piece of wheeled construction equipment are appropriate methods of evaluation.

If soft or otherwise unsuitable subgrade areas are revealed during evaluation that cannot be compacted to a stable and uniformly firm condition, we recommend that: (1) the unsuitable soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted, if practical; or (2) the unsuitable soils be removed and replaced with compacted structural fill, as needed.

Subgrade Protection and Wet Weather Considerations

Most of the near-surface soils observed in our explorations contain a significant quantity of fines and will be susceptible to disturbance during periods of wet weather. The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather can occur during any month of the year. It may be possible to conduct earthwork at the site during wet weather months provided appropriate measures are implemented to protect exposed soil. If earthwork is scheduled during the wet weather months we offer the following recommendations:

- Measures should be implemented to remove or eliminate the accumulation of surface water from work areas. The ground surface in and around the work area should be sloped so that surface water is

directed away and graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches.

- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and other soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing exposed soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent to which these soils become wet or unstable.
- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.
- Protective surfacing such as placing asphalt-treated base (ATB) or haul roads made of quarry spalls or a layer of free-draining material such as well-graded pit-run sand and gravel may be necessary to limit disturbance to completed areas. Minimum quarry spall thicknesses should be on the order of 12 to 18 inches. Typically, minimum gravel thicknesses on the order of 24 inches are necessary to provide adequate subgrade protection.

Fill Materials

Structural Fill

The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. We recommend that washed crushed rock or select granular fill, as described below, be used for structural fill during wet weather. If prolonged dry weather prevails during the earthwork phase of construction, materials with a somewhat higher fines content may be acceptable. Weather and site conditions should be considered when determining the type of import fill materials purchased and brought to the site for use as structural fill.

Material used for structural fill should be free of debris, organic contaminants and rock fragments larger than 6 inches. For most applications, we recommend that structural fill consist of material similar to "Select Borrow" or "Gravel Borrow" as described in Section 9-03.14 of the Washington State Department of Transportation (WSDOT) Standard Specifications.

Select Granular Fill

Select granular fill should consist of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on the minus ¾-inch fraction. Organic matter, debris or other deleterious material should not be present. In our opinion, material with gradation characteristics similar to WSDOT Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), or 9-03.14 (Borrow) is suitable for use as select granular fill, provided that the fines content is less than 5 percent (based on the minus ¾-inch fraction) and the maximum particle size is 6 inches.

Pipe Bedding

Trench backfill for the bedding and pipe zone should consist of well-graded granular material similar to "gravel backfill for pipe zone bedding" described in Section 9-03.12(3) of the WSDOT Standard Specifications. The material must be free of roots, debris, organic matter and other deleterious material. Other materials may be appropriate depending on manufacturer specifications and/or local jurisdiction requirements.

Trench Backfill

Trench backfill must be free of debris, organic material and rock fragments larger than 6 inches. We recommend that trench backfill material consist of material similar to "Select Borrow" or "Gravel Borrow" as described in Section 9-03.14 of the WSDOT Standard Specifications. Where excavations occur in the wet, alternative materials such as select granular fill should be considered.

On-Site Soil

Based on our subsurface explorations and experience, it is our opinion that existing site soils may be considered for use as structural fill and trench backfill, provided that they can be adequately moisture conditioned, placed and compacted as recommended and does not contain organic or other deleterious material. Based on our experience, the silty sands, silts and clays at the site are extremely moisture sensitive and will be very difficult or impossible to properly compact when wet.

In addition, it is likely that existing soils will be above optimum moisture content (OMC) when excavated, unless earthwork activities take place in the middle of summer. Even then, the soil could still be above OMC when excavated. Soils placed and compacted above OMC are typically difficult to work with and may have trouble achieving adequate compaction. If earthwork occurs during a typical wet season, or if the soils are persistently wet and cannot be dried back due to prevailing wet weather conditions or lack of drying space/time, we recommend the use of imported structural fill or select granular fill, as described above.

Fill Placement and Compaction

General

To obtain proper compaction, fill soil should be compacted near OMC and in uniform horizontal lifts. Lift thickness and compaction procedures will depend on the moisture content and gradation characteristics of the soil and the type of equipment used. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Generally, 8- to 12-inch loose lifts are appropriate for steel-drum vibratory roller compaction equipment. Compaction should be achieved by mechanical means. During fill and backfill placement, sufficient testing of in-place density should be conducted to check that adequate compaction is being achieved.

Area Fills and Pavement Bases

Fill placed to raise site grades and materials under pavements and structural areas should be placed on subgrades prepared as previously recommended. Fill material placed below structures and footings should be compacted to at least 95 percent of the theoretical maximum dry density (MDD) per ASTM International (ASTM) D 1557. Fill material placed shallower than 2 feet below pavement sections should be compacted to at least 95 percent of the MDD. Fill placed deeper than 2 feet below pavement sections should be compacted to at least 90 percent of the MDD. Fill material placed in landscaping areas should be

compacted to a firm condition that will support construction equipment, as necessary, typically around 85 to 90 percent of the MDD.

Backfill Behind Walls

Backfill behind retaining walls or below-grade structure walls should be compacted to between 90 and 92 percent of the MDD. Overcompaction of fill placed directly behind walls should be avoided. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet behind walls.

Trench Backfill

For utility excavations, we recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction, but generally should not be greater than about 18 inches above the pipe. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

Trench backfill material placed below structures and footings should be compacted to at least 95 percent of the MDD. In paved areas, trench backfill should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD in the upper 2 feet below subgrade. Fill placed below a depth of 2 feet from subgrade in paved areas must be compacted to at least 90 percent of the MDD. In non-structural areas, trench backfill should be compacted to a firm condition that will support construction equipment as necessary.

Foundation Support

General

The proposed structures at the site can be satisfactorily supported on continuous wall and isolated column footings. Exterior footings should be established at least 18 inches below the lowest adjacent grade. Interior footings can be founded a minimum of 12 inches below the top of the floor slab. Isolated column and continuous wall footings should have minimum widths of 24 and 18 inches, respectively.

Based on the groundwater conditions in our explorations and our understanding of the proposed footing elevations (bottom of footings established at or within a few feet of existing site grade) it is our opinion footing drains are not necessary to maintain bearing support as provided in this report. However, because of the potential for near-surface seepage during wetter times of the year and from irrigation and potential landscaping, footing drains should be considered to maintain drier conditions around the structure and to reduce groundwater seepage that could migrate below the building slab.

The sections below provide our recommendations for foundation bearing surface preparation and foundation design parameters.

Foundation Bearing Surface Preparation

Shallow footing excavations should be performed using a smooth-edged bucket to limit bearing disturbance. Foundations should bear on existing proof-compacted mineral (non-organic) fill, native glacial soils or on structural fill extending to these soils. The bearing surface should be compacted as necessary to a firm, unyielding condition. Loose or disturbed materials present at the base of footing excavations should be removed or compacted.

If structural fill is placed below footings as either replacement of overexcavated soils or to establish a bearing pad, we recommend the structural fill extend laterally beyond the foundation perimeter a distance equal to the depth of fill (measured from the base of the footing where necessary), or 3 feet, whichever is less.

Foundation bearing surfaces should not be exposed to standing water. If water is present in the excavation, it must be removed before placing formwork and reinforcing steel. Protection of exposed soil, such as placing a 6-inch thick layer of crushed rock or a 3- to 4-inch layer of lean-mix concrete, could be used to limit disturbance to bearing surfaces.

Prepared foundation bearing surfaces should be evaluated by a member of our firm prior to placement of formwork or reinforcing steel to verify that bearing surface has been prepared in accordance with our recommendations or to provide recommendations for remediating unsuitable bearing soils.

Allowable Soil Bearing Pressure

Shallow foundations bearing on subgrades prepared as recommended may be designed using an allowable soil bearing pressure of 3,000 pounds per square foot (psf). This bearing pressure applies to the total of dead and long-term live loads and may be increased by one-third when considering total loads, including earthquake or wind loads. These are net bearing pressures. The weight of the footing and overlying backfill can be ignored in calculating footing sizes. These bearing pressures are appropriate for shallow foundations constructed within about 2 feet of existing site grade. We should be consulted if foundations will be constructed at elevations lower than about 2 feet of existing site grade.

Foundation Settlement

Disturbed soil must be removed from the base of footing excavations and the bearing surface should be prepared as recommended. Provided these measures are taken, we estimate the total static settlement of shallow foundations will be on the order of 1 inch or less for the bearing pressures presented above. Differential settlements could be on the order of ¼ to ½ inch between similarly loaded foundations or over a distance of 50 feet of continuous footings. The settlements should occur rapidly, essentially as loads are applied. Settlements could be greater than estimated if disturbed or saturated soil conditions are present below footings.

Lateral Resistance

The ability of the soil to resist lateral loads is a function of the base friction, which develops on the base of foundations and slabs, and the passive resistance, which develops on the face of below-grade elements of the structure as these elements move into the soil. For cast-in-place foundations supported in accordance with the recommendations presented above, the allowable frictional resistance on the base of the foundation may be computed using a coefficient of friction of 0.40 applied to the vertical dead-load forces. If precast foundations are included as part of project plans, we can provide specific recommendations for base friction resistance for precast foundations. The allowable passive resistance on the face of the foundation or other embedded foundation elements may be computed using an equivalent fluid density of 300 pounds per cubic foot (pcf).

These values include a factor of safety of about 1.5. The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total. The top foot of soil should be neglected when calculating passive lateral earth pressure unless the area adjacent to the foundation is covered with pavement or a slab-on-grade.

Slab-on-Grade Floors

Slab-on-grade floors should bear on existing mineral fill, native glacial soils or on structural fill extending to these soils and should be prepared as recommended in the "Subgrade Preparation" section of this report. We recommend the slab subgrades be observed by a member of our firm during construction. Disturbed areas should be compacted, if possible, or removed and replaced with compacted structural fill. In all cases, the exposed soil should be compacted to a firm and unyielding condition.

We recommend the slab-on-grade floors be underlain by a minimum 6-inch-thick capillary break layer consisting of clean sand and gravel, crushed rock, or washed rock. The capillary break material should contain less than 3 percent fine material based on the percent passing the ¾-inch sieve size. Provided that loose soil is removed and the subgrade is prepared as recommended, we recommend slabs-on-grade be designed using a modulus of subgrade reaction of 200 pounds per cubic inch (pci). We estimate that settlement for slabs-on-grade constructed as recommended will be less than ¾ inch for a floor load of up to 500 psf.

Based on our understanding of subsurface conditions at the site it is our opinion that an underslab drain system is not necessary. If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to slab), a waterproof liner may be placed as a vapor barrier below the slab.

Retaining Walls and Below-Grade Structures

Design Parameters

We recommend the following lateral earth pressures be used for design of conventional retaining walls and below-grade structures. Our design pressures assume that the ground surface around the retaining structures will be level or near level. If drained design parameters are used, drainage systems must be included in the design in accordance with the recommendations presented in the "Drainage" section below.

- Active soil pressure may be estimated using an equivalent fluid density of 35 pcf for the drained condition.
- Active soil pressure may be estimated using an equivalent fluid density of 80 pcf for the undrained condition; this value includes hydrostatic pressures.
- At-rest soil pressure may be estimated using an equivalent fluid density of 55 pcf for the drained condition.
- At-rest soil pressure may be estimated using an equivalent fluid density of 90 pcf for the undrained condition; this value includes hydrostatic pressures.
- For seismic considerations, a uniform lateral pressure of 14 H psf (where H is the height of the retaining structure or the depth of a structure below ground surface) should be added to the lateral earth pressure.
- An additional 2 feet of fill representing a typical traffic surcharge of 250 psf should be included if vehicles are allowed to operate within a zone equal to the height of the retaining walls. Other surcharge loads should be considered on a case-by-case basis.

The active soil pressure condition assumes the wall is free to move laterally 0.001 H, where H is the wall height. The at-rest condition is applicable where walls are restrained from movement. The above

recommended lateral soil pressures do not include the effects of sloping backfill surfaces or surcharge loads, except as described. Overcompaction of fill placed directly behind retaining walls or below-grade structures must be avoided to limit lateral pressures placed on the wall. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet of retaining walls and below-grade structures.

Retaining wall foundation bearing surfaces should be prepared following the "Foundation Bearing Surface Preparation" section of this report. Provided bearing surfaces are prepared as recommended, retaining wall foundations may be designed using the allowable soil bearing value and lateral resistance values presented above for building foundation design. We estimate settlement of retaining structures will be similar to the values previously presented for structure foundations.

Drainage

If retaining walls or below-grade structures are designed using drained parameters, a drainage system behind the structure must be included to collect water and prevent the buildup of hydrostatic pressure against the structure. We recommend the drainage system include a zone of free-draining backfill a minimum of 18 inches in width against the back of the wall. The drainage material should consist of coarse sand and gravel containing less that 5 percent fines based on the fraction of material passing the ¾-inch sieve.

A perforated, rigid, smooth-walled drain pipe with a minimum diameter of 4 inches should be placed along the base of the structure within the free-draining backfill and extend for the entire wall length. The drain pipe should be metal or rigid PVC pipe and be sloped to drain by gravity. Discharge should be routed to appropriate discharge areas and to reduce erosion potential. Cleanouts should be provided to allow routine maintenance. We recommend roof downspouts or other types of drainage systems not be connected to retaining wall drain systems.

Stormwater Infiltration

General

We evaluated stormwater infiltration rates at the site following methodology presented in the 2016 SWDM. We completed two PITs. TP-1 (PIT-1) was located in the grass area within the proposed overflow parking addition on the west side of the campus. TP-3 (PIT-2) was within the grass field located on the southwest corner of the campus. The sections below further describe our methodology and provide recommended infiltration rates for design.

Pilot Infiltration Tests

Methodology

The PITs were conducted following GeoEngineers' standard methodology for stormwater facilities in Western Washington. The GeoEngineers' procedure is a synthesis of best practices and, in our opinion, meets the intended procedures set forth in the 2016 SWDM.

Upon reaching the target excavation depth, a graduated yard stick was driven into the floor of the test pit as a visual reference for monitoring water levels during testing. A piezoelectric pressure transducer was secured to the bottom of the yard stick to provide accurate water-level measurements at 15-second intervals throughout the duration of the test.

GeoEngineers' PIT procedure consists of a 6-hour (minimum) saturation period where the water depth in the PIT is raised and lowered between about 12 and 16 inches in a series of falling-head stages. Water level measurements collected by the pressure transducer during each water drop is used to calculate the apparent infiltration rate for each stage. The falling-head stage methodology is intended to fully saturate the soils below the base of the PIT while allowing for a direct measurement of when saturated or near saturated conditions have been achieved. This is usually manifested by a progressive decline in the apparent infiltration rate until the rate approximately stabilizes. The stabilized rate corresponds to the saturated infiltration rate of the soil.

Once a stabilized infiltration rate is observed and a minimum of 6 hours of saturation time has elapsed, the infiltration rate was estimated from the last stage for each PIT. The total test duration for TP-1 (PIT-1) and TP-3 (PIT-2) was about 7½ hours and 7¼ hours, respectively. After the PITs were complete, the test pits were excavated deeper. Groundwater seepage was not observed at either PIT location. However, we observed some lateral infiltration influence at TP-1 (PIT-1). The water used in the test was observed to infiltrate into the more permeable silty sand with gravel and quarry spalls and sand with silt layers underlying the 3-inch layer of hot-mix asphalt at about 1¾ feet bgs. At the conclusion of PIT-1, while advancing the test pit deeper we observed the water to migrate back into the excavation from these layers. In our opinion, the initial infiltration rate measured in this PIT is overstated, due to the higher permeability of the silty sand and quarry spalls and sand with silt. Accordingly, our recommendations below account for this effect.

Test Results

Figure 3 and Figure 4 show the measured water levels and infiltration rates at each stage of the PIT. Results indicate that saturated conditions and a stable infiltration rate was observed starting around hour 5 in PIT-1 and PIT-2.

The rates calculated in our PITs are representative of the measured (unfactored) infiltration rate of the soils at the test location. The SWDM recommends that correction factors be applied to the measured infiltration rates to estimate the long-term design infiltration rate. Different correction factors are applied depending on the facility type. The correction factors account for the number of infiltration tests in relation to the size of the infiltration facility area, site variability, test method and other factors.

Table 2 summarizes the partial and total correction factor(s) that, in our opinion, are suitable for design. Correction factors were selected based on our project understanding, observed soils conditions and our experience assisting in the design of stormwater infiltration facilities. The total correction factor (CF) is equal to the product of the partial correction factors.

TABLE 2. PIT CORRECTION FACTOR SUMMARY

Issue	Partial Correction Factor
Test Method ($F_{testing}$)	0.5
Geometry/Depth to Groundwater ($F_{geometry}$)	1.0
Long-Term Plugging ($F_{plugging}$)	0.7
Total Correction Factor = $F_{testing}$ x $F_{geometry}$ x $F_{plugging}$	CF = 0.35

Table 3 summarizes the measured and long-term infiltration rates determined in the PITs considering a CF = 0.35.

TABLE 3. INFILTRATION RATE SUMMARY

Pilot Infiltration Test Number	Measured Infiltration Rate (in/hr)	Long-Term Design Infiltration Rate (in/hr)
TP-1 (PIT-1)	0.35	0.1
TP-3 (PIT-2)	0.37	0.1

A discussion and further recommendations based on the testing results are provided below.

Discussion and Additional Considerations

General

Glacial soil deposits were observed at shallow depths at each PIT location. Fine-grained recessional lacustrine deposits were observed at about 3½ feet bgs at TP-1 (PIT-1) and dense glacial till was observed at less than 1-foot bgs at TP-3 (PIT-2). The regional groundwater table was not observed at either PIT location.

We have assumed that, if infiltration facilities are planned, they will serve less than about 1 acre of tributary area. The SWDM states that groundwater mounding analysis is not required for infiltration facilities serving less than 1 acre of tributary area provided that a minimum 5-foot separation is maintained between the bottom of the facility and seasonal high groundwater level or low permeability stratum (i.e., recessional lacustrine deposits and glacial till). At the locations tested where low permeability stratum was observed at shallow depths, this minimum separation would not be maintained. However, it is our opinion that a groundwater mounding analysis is not required provided that the long-term design infiltration rates listed above are used for design, because they represent the lower infiltration rate of the low permeability stratum.

Based on the PIT results, observed subsurface conditions and our experience, it is our opinion the soils at the locations tested have limited stormwater infiltration potential. The long-term design infiltration rates provided above may not be appropriate for large-scale infiltration facilities, such as infiltration ponds, but are suitable for permeable pavement and small footprint or low volume facilities. Other requirements outlined in the SWDM should be evaluated as required.

We request that if infiltration facilities are incorporated into site improvements, that we review the planned facility types, sizes and locations in-order to provide additional recommendations, as necessary.

Additional considerations are provided below for the areas we completed our PITs.

TP-1 (PIT-1) (Overflow Parking Addition)

We have assumed that permeable pavement may be considered by the design team for the proposed overflow parking addition on the west side of the campus. Accordingly, the approximate 3-inch thick layer of hot-mix asphalt observed between about 1½ and 1¾ feet bgs should be removed and the permeable pavement facility should include an adequately thick stormwater storage layer section. We recommend that additional explorations be completed to confirm the extents and/or presence of the hot-mix asphalt layer

within the proposed footprint of the overflow parking addition. We can assist with additional explorations if requested.

Recommendations for permeable pavement design is discussed in further detail in the "Pervious Pavement" section of this report.

TP-3 (PIT-2) (Grass Field-Southwest Corner of Campus)

We have assumed that an infiltration pond may be considered by the design team to be located within the current grass field in the southwest corner of campus. We discussed above that based on our observations and the test results that infiltration ponds may not be appropriate. If an infiltration pond or other infiltration facility types are proposed in this area, we recommend that additional testing and explorations be completed within the footprint of each proposed facility. We can assist with additional testing and explorations if requested.

Pavement Recommendations

Conventional Asphalt Concrete Pavements

General

We provide recommended conventional ACP sections below, which are based on our experience because estimated traffic loading is not available. We also provide alternate sections wherein ATB is substituted for the crushed surfacing base course layer. These pavement sections may not be adequate for heavy construction traffic loads such as those imposed by concrete transit mixers, dump trucks or cranes. The contractor should consider planned construction loading and determine whether the design sections are sufficient to support construction loading without damage. The recommended sections assume that final improvements surrounding the conventional ACP will be designed and constructed such that stormwater or excess irrigation water from landscape areas does not accumulate below the pavement section or pond on pavement surfaces.

Pavement subgrade should be prepared, placed and observed as previously described. Crushed surfacing base course and subbase should be moisture conditioned to near optimum moisture content and compacted to at least 95 percent of MDD (ASTM D 1557).

Crushed surfacing base course should conform to applicable sections of 4-04 and 9-03.9(3) of the WSDOT Standard Specifications. Hot mix asphalt should conform to applicable sections of 5-04, 9-02 and 9-03 of the WSDOT Standard Specifications.

Standard-Duty ACP – Automobile Driveways and Parking Areas

- 2 inches of hot mix asphalt, class ½ inch, PG 64-22.
- 4 inches of crushed surfacing base course.
- 6 inches of subbase consisting of select granular fill to provide a uniform grading surface and pavement support, to maintain drainage, and to provide separation from subgrade soils.
- Existing site soils or structural fill prepared in accordance with the "Subgrade Preparation" section.

Heavy-Duty ACP – Areas Subject to Heavy Truck Traffic

- 3 inches of hot mix asphalt, class ½ inch, PG 64-22.
- 6 inches of crushed surfacing base course.

- 6 inches of subbase consisting of select granular fill to provide a uniform grading surface and pavement support, to maintain drainage, and to provide separation from subgrade soils.
- Existing site soils or structural fill prepared in accordance with the "Subgrade Preparation" section.

Pervious Pavement

General

Our recommendations for pervious pavement design sections are based on information provided in the technical guidance manual for LID (Puget Sound LID manual), completed by the Puget Sound Partnership (December 2012) and our experience designing permeable pavements in the region. The pavement sections presented below are suitable for use in driveway and parking areas and may not be suitable for use on surface streets or in areas with heavy traffic loads such as the bus loop area or entrances to the site. The design of pervious pavements for stormwater management should consider storage capacity of the pervious pavement system and infiltration rate of the subgrade soils. Our general recommendations are provided in the following sections; however, we recommend that final pervious pavement design should be in accordance with the complete recommendations provided in the Puget Sound LID manual.

Sections for pervious cement concrete pavement and porous asphalt pavement are presented below followed by specific recommendations for each section.

Pervious Cement Concrete Section

- 6 inches of pervious cement concrete.
- 6 inches (minimum) of permeable ballast, more permeable ballast may be required to provide adequate storage capacity for the section.
- Geotextile separation liner.
- Treatment layer (if necessary).
- Subgrade prepared as recommended below.

Porous Asphalt Concrete Section

- 4 inches of porous hot mix asphalt concrete.
- 6 inches (minimum) of permeable ballast, more permeable ballast may be required to provide adequate storage capacity for the section.
- Geotextile separation liner.
- Treatment layer (if necessary).
- Subgrade prepared as recommended below.

Pavement

Permeable pavements should be open graded and should have a minimum infiltration rate of at least 100 inches per hour when newly installed. Field infiltration tests should be considered on newly placed permeable pavements to verify the infiltration rate.

Permeable Ballast

We recommend a minimum 6-inch thick permeable ballast layer that meets the specification for American Public Works Association (APWA) General Special Provision (GSP) 9-03.9(2) Option 1 (shown in Table 4 below). A thicker permeable ballast layer may be necessary to provide sufficient storage capacity for the design infiltration rate. In general, the permeable ballast can be considered to have a porosity of 30 percent.

TABLE 4. GRADATION SPECIFICATION FOR PERMEABLE BALLAST

Sieve Size	Percent Passing
2½ inch	99-100
2 inches	65-100
¾ inch	40-80
No. 4	0-5
No. 100	0-2
% Fracture	95

Permeable ballast layers between 6 and 12 inches thick should be placed as a single lift. The ballast should be lightly compacted to a firm unyielding condition. Overcompaction of the ballast can result in reduced permeability. The prepared ballast layer should be observed by the geotechnical engineer to ensure that the ballast has been adequately compacted prior to placement of the permeable pavement. If the permeable ballast layer is thicker than 12 inches, it should be placed and compacted in multiple lifts not exceeding 12 inches in thickness.

Treatment Layer

Stormwater must be treated prior to infiltration. Stormwater can be captured and pretreated prior to infiltration, treatment layers can be built into the infiltration systems, or the existing site soils must meet treatment criteria outlined in the SWDM. In order to be suitable for stormwater treatment existing site soils must have a cation exchange capacity (CEC) greater than 5 milliequivalents/100 grams and an organic content of at least 1 percent. Completing CEC and organic content tests on the site soils was beyond our scope. Site soils should be tested to determine if they are suitable for stormwater treatment.

A geotextile separation fabric should be included between the bottom of the treatment layer and the prepared subgrade to prevent the treatment media from migrating into the subgrade soils. The separation geotextile should be non-woven and meet the requirement of WSDOT Standard Specification 9-33.1 for separation.

Subgrade Preparation

Subgrades below permeable pavement sections should be lightly compacted to a firm and unyielding condition before constructing the permeable pavement section; however, overcompaction of the subgrade should be avoided. Prepared subgrades should be protected from construction traffic, standing water or other disturbance. If portions of the subgrade become disturbed or are overcompacted, the subgrade should be scarified to a minimum depth of 8 inches and recompacted. The subgrade should be recompacted to between 90 and 92 percent of the MDD.

Protection, Maintenance and Icing

It is imperative that soils are not tracked onto pervious pavement surfaced areas during construction. Periodic visual inspections should be performed throughout the pavement life to determine if pervious pavement surfaces are clogged with fine soil or vegetation. Surfaces should be swept with a high-efficiency or vacuum sweeper regularly (typically at least two to four times per year) and washed with a high-pressure hose at least once per year.

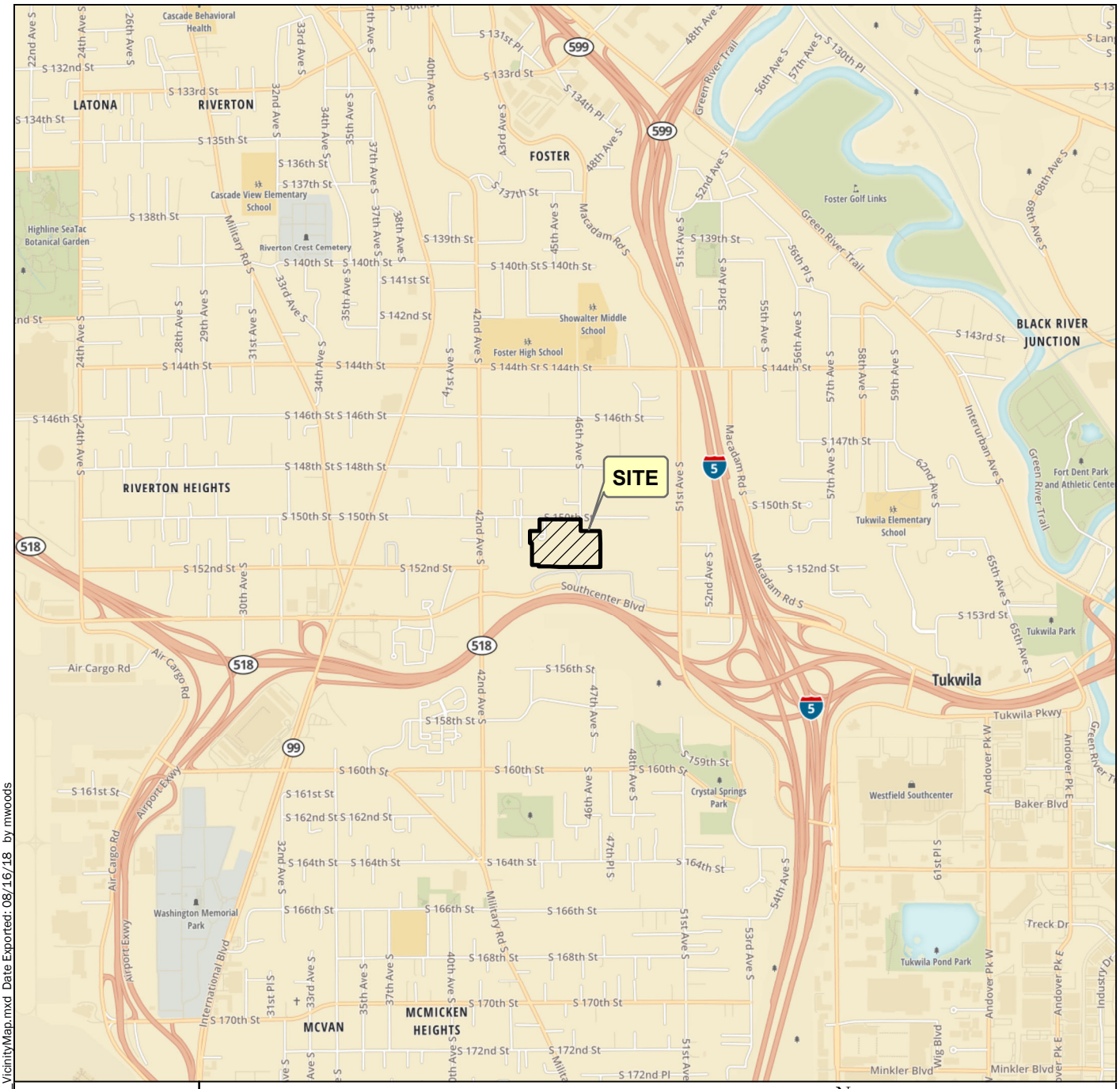
Because the relatively porous base and subbase layers allow some air movement below the pavement, pervious pavement surfaces may become icy more easily than conventional pavement surfaces. This problem is similar to differential icing of bridges and elevated road structures. Users should be made aware of the possibility of differential icing if pervious pavements are used.

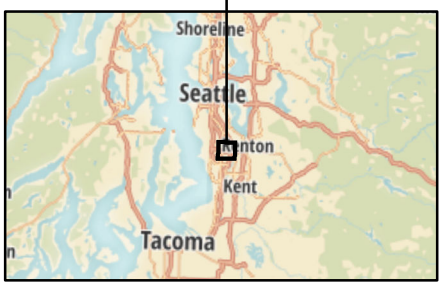
LIMITATIONS

We have prepared this report for Tukwila School District, No. 406 for the Thorndyke Elementary School Improvements project in Tukwila, Washington. Tukwila School District may distribute copies of this report to owner's authorized agents and regulatory agencies as may be required for the Project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to the services or this report.

Please refer to Appendix B titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.





N
W E
S

2,000 0 2,000

Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Thorndyke Elementary School Improvements
Tukwila, Washington

GeoEngineers

Figure 1

\\geoengineers.com\wan\Projects\23\23537001\GIS\MXD\23537001_F01_VicinityMap.mxd Date Exported: 08/16/18 by mwoods

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Aerial from Google Earth dated 5/13/2018.

Projection: NAD83 Washington State Planes, North Zone, US Foot

Legend

Site Boundary

TP-1 (PIT-1) Test Pit by GeoEngineers, 2018

N W E S

100 0 100
Feet

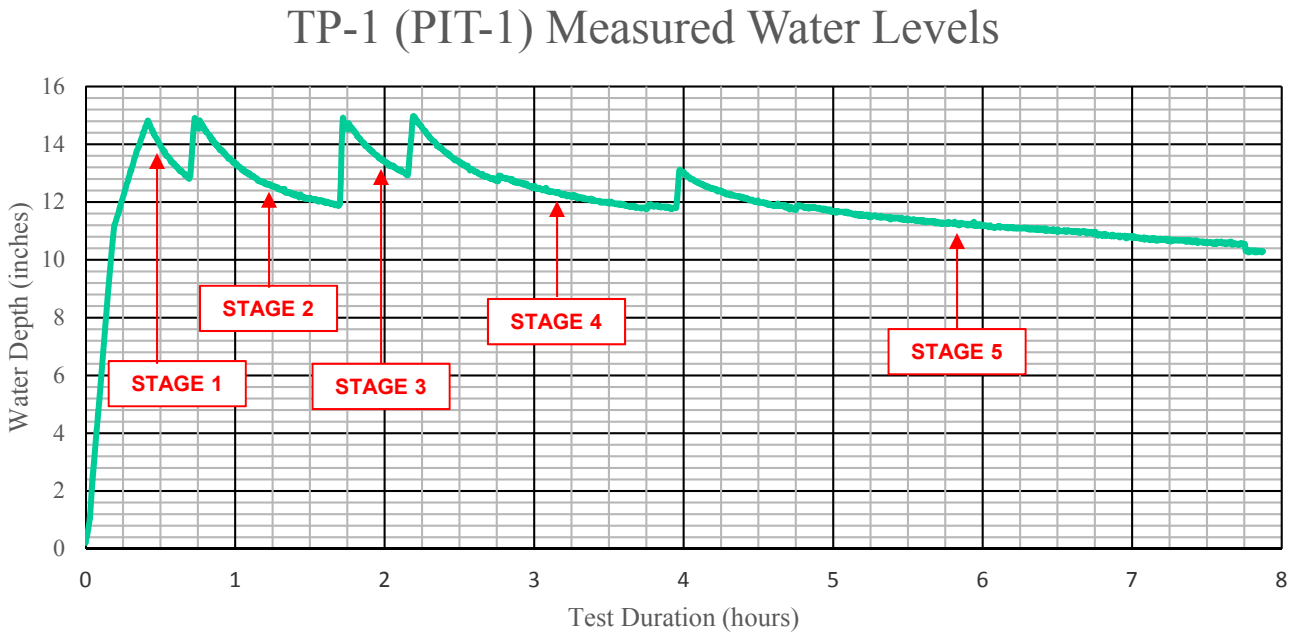
Site Plan

Thorndyke Elementary School Improvements
Tukwila, Washington

GeoEngineers

Figure 2

\\geoengineers.com\WAN\Projects\23\23537001\CAD\00\GeoTech\2353700100_F02_Site Plan.dwg TAB:F02 Date Exported: 08/16/18 - 14:05 by mwoods



TP-1 (PIT-1) Measured (Short-Term) Infiltration Rates	
Stage	**Measured Infiltration Rate (in/hr)**
1	7.02
2	2.81
3	4.32
4	0.93
5	0.35

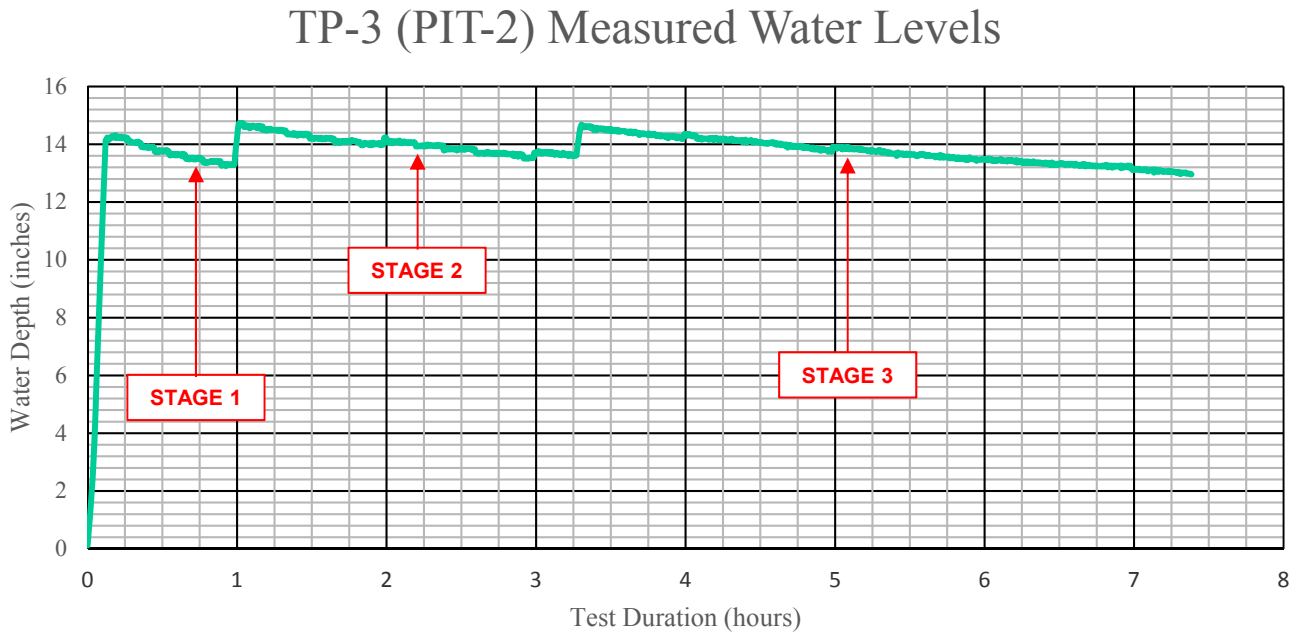
TP-1 (PIT-1) Results

Thorndyke Elementary School Improvements
Tukwila, Washington

GeoEngineers

Figure 3

23537-001-00 Date Exported: 081718



TP-3 (PIT-2) Measured (Short-Term) Infiltration Rates	
Stage	**Measured Infiltration Rate (in/hr)**
1	1.27
2	0.46
3	0.37

TP-3 (PIT-2) Results

Thorndyke Elementary School Improvements
Tukwila, Washington

GeoEngineers

Figure 4

23537-001-00 Date Exported: 081718

APPENDIX A
Subsurface Explorations and Laboratory Testing

APPENDIX A
SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

Subsurface Explorations

Test Pits and Pilot Infiltration Tests

Subsurface conditions for the proposed Thorndyke Elementary School Improvements project were explored by excavating five test pits on July 30, 2018 at the approximate locations shown on Figure 2. Pilot infiltration tests (PIT) were completed at about 3¼ feet and 4 feet below ground surface (bgs) at TP-1 (PIT-1) and TP-3 (PIT-2), respectively. The test pits were excavated to depths between about 8 and 11 feet bgs using a subcontracted backhoe and operator to GeoEngineers. After each test pit was completed, the excavation was backfilled using the generated material. The backfill was compacted using the bucket of the backhoe.

Our field representative obtained samples, classified the soils encountered, and maintained a detailed log of each exploration. The relative densities noted on the test pit logs are based on the difficulty of excavation and our experience and judgment. The samples were collected and retained in sealed plastic bags and then transported back to our office. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 through A-6.

The locations of the test pits were determined via an electronic tablet with global positioning system (GPS) software. The locations of the explorations should be considered approximate.

Laboratory Testing

Soil samples obtained from the borings were transported to GeoEngineers laboratory. Representative soil samples were selected for laboratory tests to evaluate the pertinent geotechnical engineering characteristics of the site soils and to confirm our field classification.

Our testing program consisted of the following:

- Five grain-size distribution analyses (four sieve analyses [SA] and one hydrometer analysis [HA])
- Four moisture content determinations (MC)

Tests were performed in general accordance with test methods of ASTM International (ASTM) or other applicable procedures. The following sections provide a general description of the tests performed.

Sieve Analysis (SA)

Grain-size distribution analyses were completed on selected samples in general accordance with ASTM Test Method D 6913. This test method covers the quantitative determination of the distribution of particle sizes in soils. Typically, the distribution of particle sizes larger than 75 micrometers (µm) is determined by sieving. The results of the tests were used to verify field soil classifications and determine pertinent engineering characteristics. Figures A-7 and A-8 present the results of our sieve analyses.

Hydrometer Analysis (HA)

A grain-size distribution analysis was performed on a selected sample in general accordance with ASTM Test Method D 422. This test method covers the quantitative determination of the distribution of particle sizes in soils. Typically, the distribution of particle sizes larger than 75 µm is determined by sieving, and the distribution of particle sizes smaller than 75 µm is determined by a sedimentation process using a hydrometer. The hydrometer analysis alone determines the distribution of particle sizes smaller than 2 millimeters (mm). The hydrometer test sample included particle sizes smaller than 2 mm but did not include a corresponding sieve analysis. The results of the test were used to verify field soil classifications and determine pertinent engineering characteristics. Figure A-7 presents the results of our hydrometer analysis.

Moisture Content (MC)

The moisture content of selected samples was determined in general accordance with ASTM Test Method D 2216. The test results are used to aid in soil classification and correlation with other pertinent engineering soil properties. The results are presented on the test pit logs at the depth tested.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers

Figure A-1

Date Excavated	7/30/2018	Total Depth (ft)	8.5	Logged By SAH Checked By CRN	Excavator Kelly's Excavating Equipment Komatsu WB 140 (Backhoe)	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	230 NAVD88	Easting (X) Northing (Y)	1283035 174068	Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
229	1		1		SOD	Approximately 2 inches sod (grass)			
					SM	Approximately 3 inches gray silty fine to medium sand with occasional organic matter (roots) (medium dense, moist) (fill)			
					SP-SM	Gray fine to medium sand with silt and gravel and occasional deleterious debris (wood, metal pipe fragment, concrete, bricks) (medium dense, moist)			
228	2				AC	Approximately 3-inch layer hot mix asphalt			
					SM	Brown silty fine to coarse sand with gravel and quarry spalls (dense, moist)			
					SP-SM	Gray fine to medium sand with silt and occasional gravel (dense, moist)			
227	3		2 SA				11	8	Pilot Infiltration Test completed at approximately 3¼ feet
226	4				ML/CL	Gray to brown-gray with iron oxide staining alternating laminations of silt and clay with occasional gravel (stiff, moist) (recessional lacustrine deposits)			
225	5								
224	6		3 HA				37		
223	7		4						
222	8		5 MC		ML	Gray silt with fine sand (stiff, moist)	28		

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-1 (PIT-1)

GeoEngineers

Project: Thorndyke Elementary School Improvements
Project Location: Tukwila, Washington
Project Number: 23537-001-00

Figure A-2
Sheet 1 of 1

Date Excavated 7/30/2018	Total Depth (ft) 10	Logged By SAH Checked By CRN	Excavator Kelly's Excavating Equipment Komatsu WB 140 (Backhoe)	See "Remarks" section for groundwater observed See "Remarks" section for caving observed	
Surface Elevation (ft) 220 Vertical Datum NAVD88		Easting (X) 1283731 Northing (Y) 174067		Coordinate System WA State Plane North Horizontal Datum NAD83 (feet)	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
219	0				SOD	Approximately 2 inches sod (grass)			
					SM	Approximately 10 inches gray silty fine to medium sand with gravel and occasional organic matter (roots) (dense, moist) (fill)			
	1				SM	Gray silty fine to coarse sand with gravel and occasional cobbles and deleterious debris (wood debris) (very dense, moist)			
218	2								
217	3				SM	Gray-brown silty fine sand with occasional gravel and deleterious debris (PVC pipe fragments at approximately 4 feet) (very dense, moist)			
216	4		1 SA				10	40	
215	5		2 MC		ML	Dark brown silt with organic matter and occasional sand and gravel (medium stiff, moist)	69		Minor caving observed at approximately 5 feet Includes woody debris
214	6		3		SM	Gray silty fine to medium sand with gravel and occasional organic matter and includes lenses of dark brown organic silt (medium dense, moist)			
213	7								
212	8					Grades to with occasional cobbles			
211	9		4		SM	Gray-brown silty fine to medium sand with occasional gravel and cobbles (medium dense, wet)			Slow groundwater seepage observed at approximately 9 feet on south side of test pit
210	10								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-2

GeoEngineers

Project: Thorndyke Elementary School Improvements
Project Location: Tukwila, Washington
Project Number: 23537-001-00

Figure A-3
Sheet 1 of 1

Date Excavated	7/30/2018	Total Depth (ft)	9.5	Logged By SAH Checked By CRN	Excavator Kelly's Excavating Equipment Komatsu WB 140 (Backhoe)	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	230 NAVD88	Easting (X) Northing (Y)	1283097 173939	Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
229	1				SOD	Approximately 2 inches sod (grass)			
					SM	Approximately 6 inches gray-brown silty fine to coarse sand with gravel and occasional organic matter (roots) (medium dense, moist) (fill)			
					SM	Gray-brown silty fine to medium sand with gravel and occasional cobbles (very dense, moist) (glacial till)			
228	2		1						
227	3				SM	Gray silty fine to coarse sand with gravel and occasional cobbles (very dense, moist)			
226	4		2 SA				10	14	Pilot infiltration test completed at approximately 4 feet
225	5								
224	6		3						
223	7				SM	Gray silty fine to medium sand with occasional gravel and cobbles (very dense, moist)			
222	8		4						
221	9		5						

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-3 (PIT-2)

GeoEngineers

Project: Thorndyke Elementary School Improvements
Project Location: Tukwila, Washington
Project Number: 23537-001-00

Figure A-4
Sheet 1 of 1

Date Excavated	7/30/2018	Total Depth (ft)	8	Logged By SAH Checked By CRN	Excavator Kelly's Excavating Equipment Komatsu WB 140 (Backhoe)	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	220 NAVD88	Easting (X) Northing (Y)	1283678 173939	Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
219	0				SOD	Approximately 2 inches sod (grass)			
					SM	Approximately 6 inches gray silty fine to coarse sand with gravel and occasional organic matter (roots) (medium dense, moist) (fill)			
	1				SM	Gray-brown silty fine sand with gravel and occasional cobbles and deleterious debris (glass) (very dense, moist)			
218		■	1 SA				8	33	
	2				SM	Gray-brown silty fine to medium sand with occasional gravel and cobbles (very dense, moist)			
217	3								
216		■	2						
	4				ML/CL	Stratified brown sandy silt with occasional gravel and gray clay with occasional gravel and organic matter (stiff, moist)			
215		■	3 MC				25		
	5				SM	Gray silty fine to coarse sand with gravel (medium dense, moist)			
214	6								
213	7					Grades to wet			
212	8	■	4						1-inch diameter by approximately 8 feet long metal pipe remnant encountered between about 7 and 8 feet depth.

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-4

GeoEngineers

Project: Thorndyke Elementary School Improvements
Project Location: Tukwila, Washington
Project Number: 23537-001-00

Figure A-5
Sheet 1 of 1

Date Excavated	7/30/2018	Total Depth (ft)	11	Logged By SAH Checked By CRN	Excavator Kelly's Excavating Equipment Komatsu WB 140 (Backhoe)	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	220 NAVD88	Easting (X) Northing (Y)	1283838 173955	Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
219	1				SOD	Approximately 2 inches sod (grass)			
					SM	Approximately 8 inches gray silty fine to medium sand with gravel and occasional organic matter (roots) (medium dense, moist) (fill)			
					SM	Gray-brown silty fine to coarse sand with gravel and occasional cobbles and organic matter (roots) (very dense, moist)			
218	2		1						
217	3				SM	Gray-brown silty fine to medium sand with occasional gravel and cobbles (medium dense, moist)			
216	4		2						
215	5		3 MC		ML	Gray and brown silt with sand and occasional gravel and organic matter (roots) (medium stiff, wet)	32		Minor caving observed at approximately 5¼ feet on north and south side of test pit
214	6		4		SM	Gray silty fine to medium sand with gravel and occasional cobbles and organic matter (medium dense, moist)			
213	7								
212	8								
211	9								
210	10								
209	11		5		ML	Brown-gray with occasional iron oxide staining silt (very stiff, moist) (recessional lacustrine deposits)			

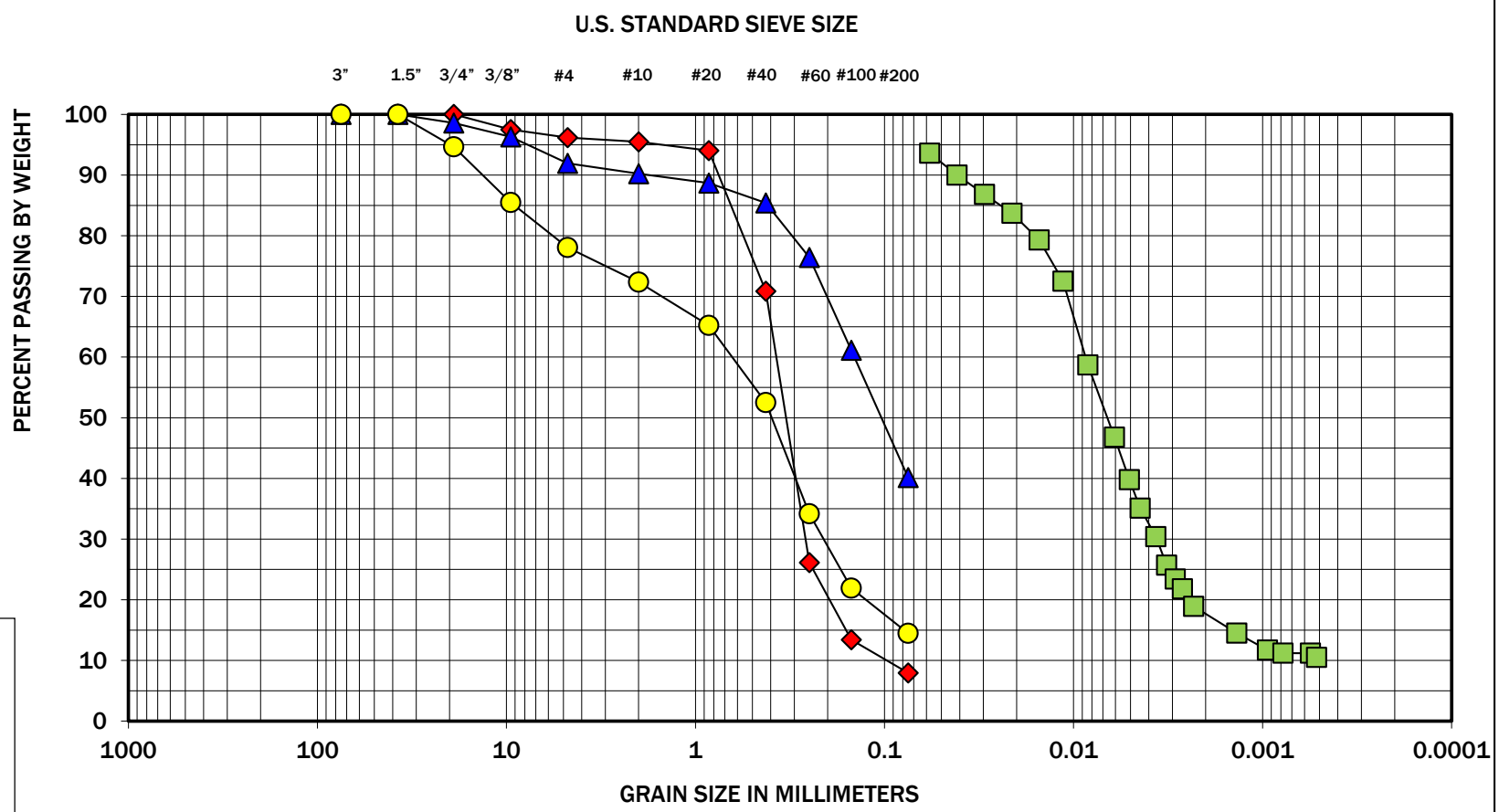
Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Test Pit TP-5

GeoEngineers

Project: Thorndyke Elementary School Improvements
Project Location: Tukwila, Washington
Project Number: 23537-001-00

Figure A-6
Sheet 1 of 1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Test Pit Number	Depth (feet)	Moisture (%)	Laboratory Soil Description
◆	TP-1 (PIT-1)	3.25	1	Fine to medium sand with silt (SP-SM)
■	TP-1 (PIT-1)	5.5	37	Silt (ML)
▲	TP-2	3.5	10	Silty fine sand with occasional gravel (SM)
●	TP-3 (PIT-2)	3.75	10	Silty fine to medium sand with gravel (SM)

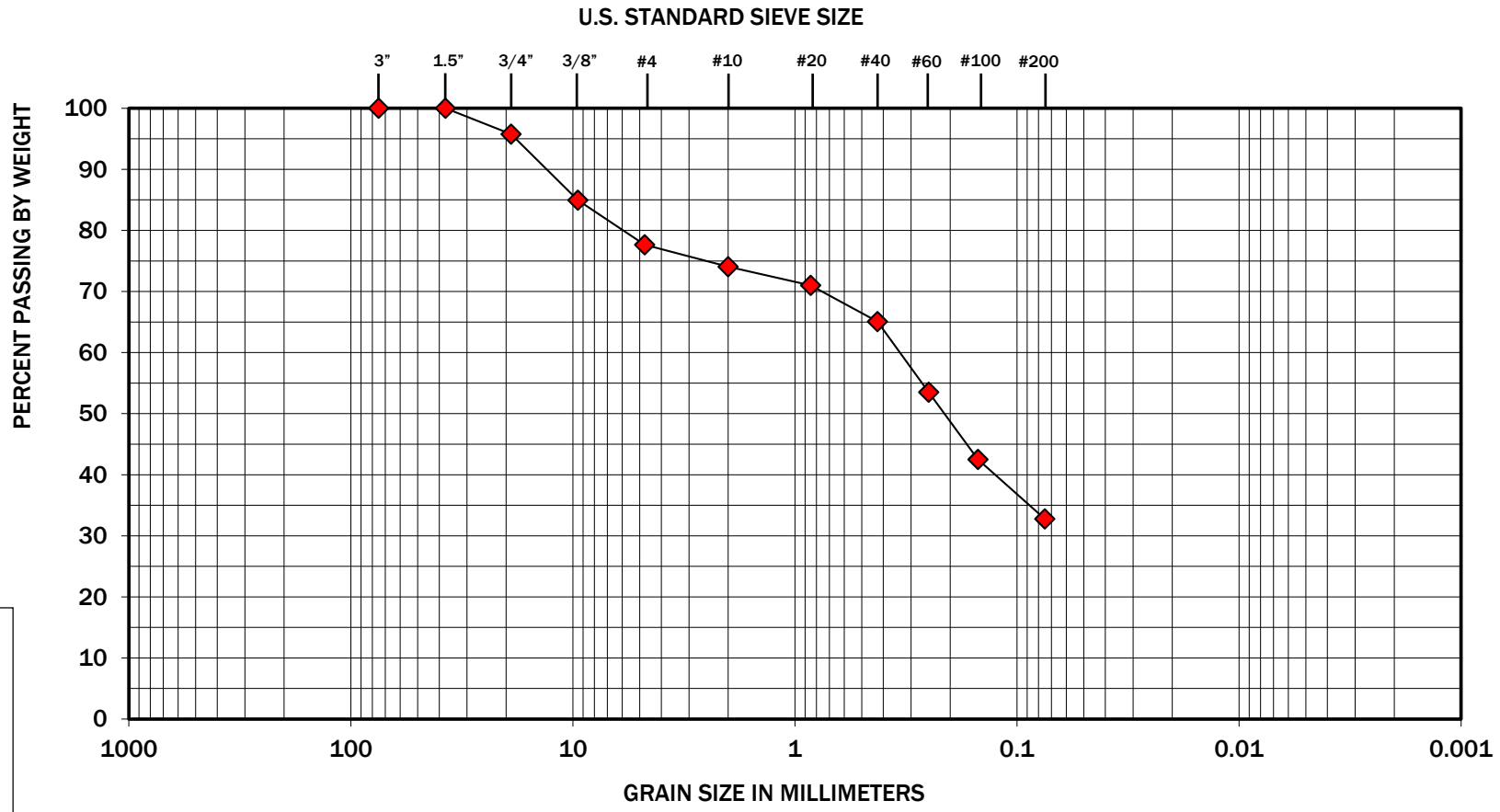
The grain size analysis results were obtained in general accordance with ASTM D 6913. The Hydrometer analysis results were obtained in general accordance with ASTM D422

GeoEngineers

Figure-A-7

Thorndyke Elementary School Improvements
Tukwila, Washington

Sieve-Hydrometer Analysis Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Test Pit Number	Depth (feet)	Moisture (%)	Laboratory Soil Description
◆	TP-4	1.5	8	Silty fine sand with gravel (SM)

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The grain size analysis results were obtained in general accordance with ASTM D 6913.

Sieve Analysis Results

Thorndyke Elementary School Improvements
Tukwila, Washington

GeoEngineers

Figure A-8

APPENDIX B
Report Limitations and Guidelines for Use

APPENDIX B
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Tukwila School District and for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Tukwila School District, No. 406 dated July 24, 2018 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for Thorndyke Elementary School in Tukwila, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Geotechnical and Geologic Findings are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations are Not Final

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions

elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project- specific knowledge and resources.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

THORNDYKE ELEMENTARY SCHOOL

CRITICAL AREAS REPORT

Grette Associates LLC
ENVIRONMENTAL CONSULTANTS

THORNDYKE ELEMENTARY SCHOOL

CRITICAL AREAS REPORT

PREPARED FOR:

TUKWILA SCHOOL DISTRICT
C/O JEFF FEENEY
DIRECTOR OF EDUCATION MANAGEMENT
KMB ARCHITECTS
906 COLUMBIA STREET SW, SUITE 400
OLYMPIA, WA 98501

PREPARED BY:

GRETTE ASSOCIATES[LLC]
2102 NORTH 30TH STREET, SUITE A
TACOMA, WASHINGTON 98403
(253) 573-9300

OCTOBER 2018

CHAD WALLIN
BIOLOGIST

DATE

Grette Associates LLC
ENVIRONMENTAL CONSULTANTS

TABLE OF CONTENTS

1 INTRODUCTION 3
2 FEATURE SUMMARY 3
3 BACKGROUND 5
3.1 Existing Conditions 5
3.2 Local Critical Areas Inventory 5
3.3 National Wetlands Inventory 5
3.4 Sensitive Wildlife and Plants 5
3.5 Forest Practice Rules 6
3.6 Soil Information 6
4 METHODS 6
5 RESULTS 7
5.1 Wetland Results 7
5.2 Stream Results 8
6 REGULATORY CONSIDERATIONS 9
7 DISCLAIMER 9
8 BIOLOGIST QUALIFICATIONS 9
8.1 Chad Wallin 9
9 REFERENCES 10

LIST OF FIGURES

Figure 1. Vicinity map 3
Figure 2. Typical conditions within the identified micro-ravines.....4
Figure 3. The Gilliam Creek Detention Pond 4
Figure 4. Typical conditions within the forested area situated within the subject property 7
Figure 5. Soil conditions observed in areas intermixed with red-osier dogwood.....7
Figure 6. Typical conditions within the identified micro-ravines.....8

LIST OF APPENDICES

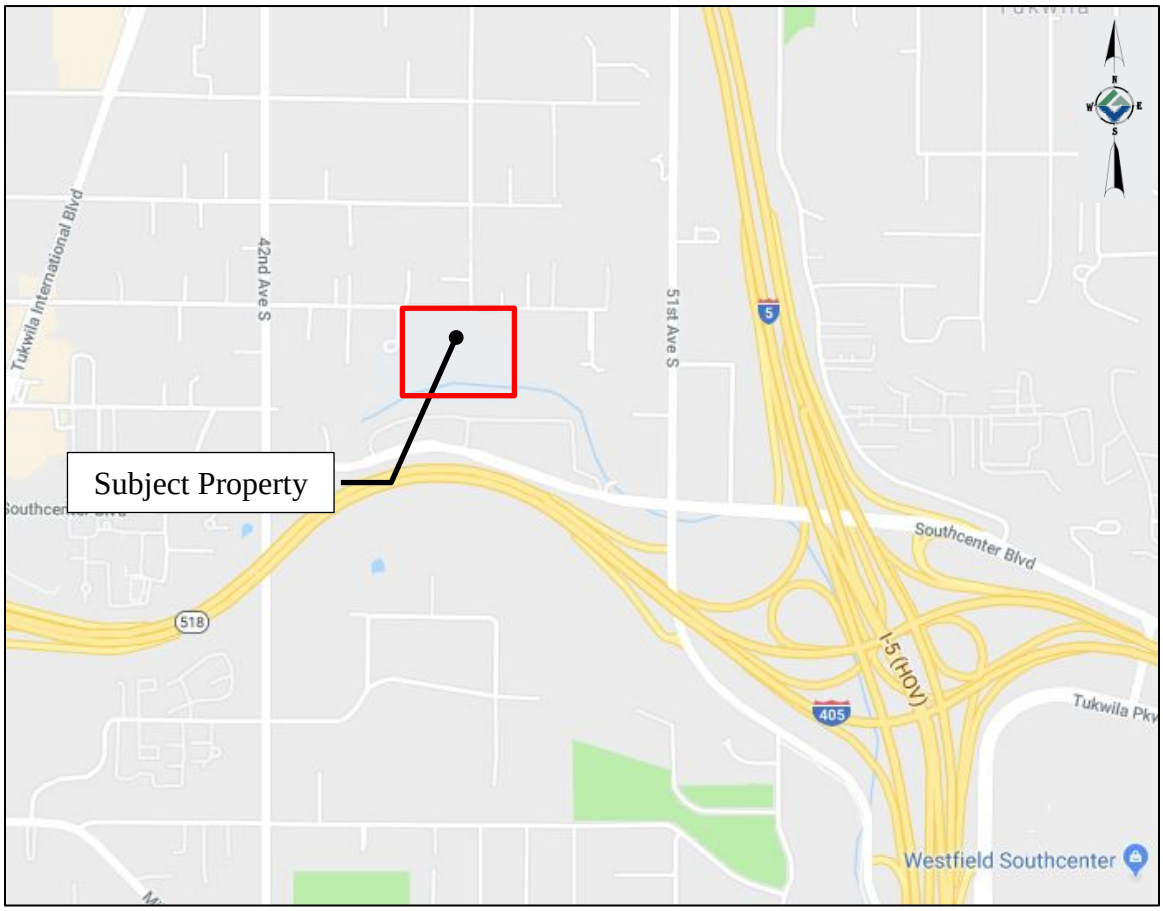
Appendix A. Queried Database Figures

1 INTRODUCTION

Grette Associates is under contract with the Tukwila School District to prepare a critical areas report that summarizes the critical areas reconnaissance performed at the Thorndyke Elementary School located at 4415 South 150th Street (King County parcel 0042000280) in Tukwila, Washington (Figure 1).

The purpose of this report is to document all wetlands and streams that are located within 300 feet of the subject property.

Figure 1. Vicinity map



2 FEATURE SUMMARY

A Grette Associates biologist visited the subject property on October 3, 2018 to conduct an assessment to identify any wetlands or streams within 300 feet of the subject property.

Grette Associates traversed the entire undeveloped area south of the existing school and visually assessed all offsite areas to identify any wetland features on or within 300 feet of the subject property. During the assessment, Grette Associates did not identify any indication of seasonal hydrology that would meet wetland hydrology indicators defined in the U.S. Army Corps of Engineers (USACE) *Federal Wetland Delineation Manual* (1987), and the USACE's *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (2010). Furthermore, while Grette Associates did identify several shrub species within

the undeveloped portion of the subject property that have a species indicator status of facultative (FAC; Lichvar 2016), Grette Associates did not identify any hydrology or soil characteristics that would indicate a potential wetland feature.

In addition to the wetland investigation, a stream evaluation was completed to identify all areas that would meet the definition of a natural water feature according to Tukwila Municipal Code (TMC) 18.06.920 and WAC 222-16-030. Grette Associates did identify two areas where topographic relief has created micro-ravines; however, no indication of seasonal surface flow was observed. More specifically, Grette Associates did not identify a bed, scouring, or sediment and/or organic deposits that would indicate regular seasonal flow. As a result, no natural water features were observed within the subject property.

Figure 2. Typical conditions within the identified micro-ravines

Photograph on the left captures conditions of the western micro-ravine within the subject property and the photograph on the right captures conditions of the eastern micro-ravine. Please note the lack of a defined bed, scouring, and vegetation in each photograph.

While no natural water features were observed within the subject property, Grette Associates did identify two offsite natural water features within 300 feet. These two features are situated west and southwest of the subject property and are associated with Gilliam Creek. Based on site observations, these two natural water features flow into the Gilliam Creek Detention Pond and into the associated flow control structure prior to flowing into a large culvert that appears to convey water east towards the I-5 and I-405 interchange.

Figure 3. The Gilliam Creek Detention Pond

Photograph on the left captures City of Tukwila signage and the photograph on the right captures the flow control structure that is west of the apartment complex along Southcenter Blvd..

3 BACKGROUND

3.1 Existing Conditions

With the exception of a narrow forested area along the southern property boundary, the subject property is largely developed. The developed area contains Thorndyke Elementary School as well as supporting amenities (parking lots, playground, athletic field, etc.).

The undeveloped portion of the subject property consists of a mature forest dominated by big-leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and black cottonwood (*Populus balsamiferia*). Beneath the forest canopy contains a sub-canopy dominated by Himalayan blackberry (*Rubus bifrons*), Indian plum (*Oemleria cerasiformis*), beaked hazelnut, red-osier dogwood (*Cornus sericea*), Oregon grape (*Berberis nervosa*), and sword fern (*Polystichum munitum*). As mentioned above, there are two micro-ravines that are situated within the forested area within the subject property.

3.2 Local Critical Areas Inventory

A review of the City of Tukwila's iMap database was conducted to identify any known critical areas within the vicinity of the subject property (City of Tukwila 2018). According to the City's database, there are two mapped streams situated within the southern portion of the subject property (Appendix A). The western stream is mapped as a Type 3 (Np) natural water feature while the eastern stream is mapped as a Type 4 (Ns) stream.

In addition to Tukwila's iMap database, the King County iMap database was queried to identify any known critical areas within the vicinity of the subject property. According to King County's database, no natural water features are mapped within the subject property (Appendix A).

3.3 National Wetlands Inventory

The U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) was queried to determine if previously-identified wetlands are present within 300 feet of the subject property (USFWS 2018). According to the NWI Interactive Online Mapper, there is one aquatic feature mapped within the subject property and one tributary west of the subject property mapped by the NWI (Appendix A). These mapped aquatic features are inconsistent with the streams mapped by the City of Tukwila.

3.4 Sensitive Wildlife and Plants

The Washington Department of Fish and Wildlife's (WDFW) Priority Habitats and Species (PHS) database on-line mapper was queried to determine if state or federally listed fish or wildlife species occur near the subject property (WDFW 2018a). According to the PHS database, no PHS features are mapped on or in the vicinity of the subject property.

Additionally, WDFW's SalmonScape on-line mapper was queried to determine what listed SalmonScape species are identified by WDFW to occur within subject property (WDFW 2018b). According to SalmonScape, the closest mapped modeled distribution of listed SalmonScape species occurs approximately 1-1.5 miles east near the I-5 and I-

405 interchange within Gilliam Creek (Appendix A). This reach of Gilliam Creek as well as the reaches upstream contains numerous partial and total fish passage barriers (Appendix A).

Please note that the stream system mapped in the vicinity of the subject property is not the mapped stream system modeled as providing habitat for listed SalmonScape species. The stream system mapped within the subject property flows east prior to flowing south approximately two miles where it flows into the Green River (near S 180th St. and Andover Park W).

The Washington Department of Natural Resources' (WDNR) Natural Heritage Information System was queried to determine if the subject property occurs in a location reported to contain high quality natural heritage wetland occurrences or occurrences of natural heritage features commonly associated with wetlands. According to WDNR data dated July 11, 2018, there are no records of rare plants or high quality native ecosystems occurring on or in the vicinity of the subject property.

3.5 Forest Practice Rules

The Washington Department of Natural Resources' (WDNR) Forest Practice Application Mapping Tool on-line mapper was queried to identify the water typing of any streams mapped by WDNR (WDNR 2018). According to WDNR, there is one stream within the subject property and one tributary west of the subject property mapped by WDNR (Appendix A). The natural water features mapped by WDNR are shown as Type F streams.

The natural water features mapped by WDNR are mapped in the same location as the two natural water features mapped by WDFW's SalmonScape database. However, WDNR does not map a natural water feature (i.e. Gilliam Creek) along the southern portion of I-405 as the City of Tukwila, King County, and WDFW maps do, which suggests that the lower reaches of Gilliam Creek are no longer situated in their historical channel.

3.6 Soil Information

According to the Natural Resources Conservation Service's (NRCS) Web Soil Survey (NRCS 2018a), the soils within the subject property consists are not mapped by the NRCS.

4 METHODS

The subject property was evaluated according to the wetland criteria as defined in the U.S. Army Corps of Engineers (USACE) *Federal Wetland Delineation Manual* (1987), and the Corps' *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (2010). In addition, all accessible areas within 300 feet of the subject property were visually assessed to identify any potential wetland features.

The definitions of a natural water feature according to Tukwila Municipal Code (TMC) 18.06.920 and WAC 222-16-030 as well as the guidance in Ecology's *Determining OHWM for Shoreline Management Act Compliance in Washington State* (Anderson et al. 2016) was used to identify all natural features on or within 300 feet of the subject property.

5 RESULTS

5.1 Wetland Results

Grette Associates traversed the subject property and all publicly accessible areas within 300 feet to identify any potential area that would meet wetland criteria defined in the USACE's *Regional Guidance* (2010). Grette Associates did not identify any areas on or within 300 feet of the subject property that indicated a potential wetland feature may be present. More specifically, the subject property is largely developed and consists of Thorndyke Elementary School. The slopes along the undeveloped forested area situated in the southern portion of the subject property are dominated by vegetation that is typically not associated with wetlands (Figure 4). At the base of the slope in the western portion of the forested area where the western micro-depression is located the vegetation includes areas intermixed with Indian plum, sword fern, English ivy (*Hedera helix*), and red-osier dogwood. Soils were investigated in this area per the USACE's *Regional Supplement* (2010); however, no hydric soil indicators were observed (Figure 5). The soils observed in the area investigated contained an upper layer (0-10 inches) of dark brown (10YR3/3) silty loam. No redox concentrations were observed.

Figure 4. Typical conditions within the forested area situated within the subject property

Photograph on the left and right captures the dominant vegetation community within the forested area. Please note the big-leaf maple, beaked hazelnut, Indian plum, Himalayan blackberry, and sword fern.

Figure 5. Soil conditions observed in areas intermixed with red-osier dogwood

Photograph on the left captures where soils were investigated and the photograph on the right captures the soil characteristics observed. Please note that the soils were moistened prior to collect matrix color.

5.2 Stream Results

Per TMC 18.06.920, natural waters generally consist of a channel with bed and/or banks where surface water flows naturally. Natural water features can contain seasonal or year-round surface flow. Grette Associates did not identify any seasonal or perennial natural water features situated at base of the identified micro-ravines located within the subject property. While the two micro-ravines contain topographic relief that may resemble a natural water feature, Grette Associates did not identify a defined channel, scouring, or sediment deposits in these features that would suggest seasonal or periodic flow. Furthermore, the base of the micro-ravines are vegetated with an assortment of native and non-native species which suggests that the ravines do not convey surface water. In Grette Associates' professional opinion, if seasonal flows occurred at the base of these micro-ravines they would be devoid of vegetation and there would be evidence of flow (channelization, scouring, and/or sediment deposits) (Figure 2 and 6).

With the exception of Tukwila's iMap, no queried databases map any natural water features within the subject property (Appendix A). King County, WDFW, and WDNR, appear to map Gilliam Creek in its historical alignment; however, according to the Gilliam Creek Basin-Stormwater Management Plan (Herrera Environmental Consultants, Inc. 2001), Gilliam Creek's subbasin that is situated west of I-5 largely consists of open channels and ditches which become piped at the downstream end prior to flowing to the main stem of Gilliam Creek (I-5 and I-405 interchange). Gilliam Creek becomes piped southwest of the subject property.

Figure 6. Typical conditions within the identified micro-ravines

Photograph on the left captures the base of the western micro-ravine and the photograph on the right captures the slope within the base of the eastern ravine. Please note the lack of watermarks, leaf litter, and vegetation within these features. No indication of seasonal flow (bed, scour, sedimentation, or wrack, etc.) was observed.

Grette Associates identified two offsite perennial natural water features. These two features are located west and southwest of the subject property and appear to be situated in the locations mapped by the queried databased (Section 3). While WDFW maps Gilliam Creek and its mapped tributaries as Type F natural waters, WDFW does not map Gilliam Creek west of the I-5 and I-405 interchange as providing fish habitat (Appendix A). Furthermore, according to the Gilliam Creek Basin-Stormwater Management Plan (Herrera Environmental Consultants, Inc. 2001), fish habitat within Gilliam Creek watershed is restricted to open-channel segments in the lower reaches downstream of I-5.

Therefore, given their observed perennial flow, the two natural water features west of the subject property are classified as a Type 3 (Np) stream and are subject to an 80 foot buffer (TMC 18.45.100).

6 REGULATORY CONSIDERATIONS

Wetlands are regulated by agencies at the local, state, and federal levels. At the local level, wetlands and their associated buffers within the City of Tukwila are regulated under Chapter 18.45 of the TMC.

At the state level, wetlands are regulated by the Washington Department of Ecology through the State Clean Water Act (Section 401). The requirement for a Water Quality Certification from Ecology for wetland impacts is triggered by an applicant's applying for a federal Clean Water Act Section 404 permit from the Corps. Ecology may also issue an Administrative Order, allowing them wetland regulatory authority without a federal nexus.

At the federal level, impacts (specifically dredging or filling) to wetlands are regulated by the Environmental Protection Agency through the US Army Corps of Engineers. The USACE administers the federal Clean Water Act (Section 404) for projects involving dredging or filling in Waters of the US (lakes, streams, marine waters, and most non-isolated wetlands).

While it is the regulatory agencies that make the final determination regarding jurisdictional status, project proponents can infer jurisdiction using the guidance provided by each agency or local government. This inference can be used to design a project based on the anticipated regulatory constraints within the project area. However, it is the project proponent's responsibility to contact each potential regulating agency and confirm their regulatory status and requirements.

7 DISCLAIMER

The findings and conclusions documented in this report have been prepared for specific application to this proposed project site. They have been developed in a manner consistent with that level of care and skill normally exercised by members of the environmental science profession currently practicing under similar conditions in the area. Our work was also performed in accordance with the terms and conditions set forth in our proposal. The conclusions and recommendations presented in this report are professional opinions based on an interpretation of information currently available to us and are made within the operation scope, budget, and schedule of this project. No warranty, expressed or implied, is made. In addition, changes in government codes, regulations, or laws may occur. Because of such changes, our observations and conclusions applicable to this site may need to be revised wholly or in part.

8 BIOLOGIST QUALIFICATIONS

8.1 Chad Wallin

Chad Wallin is a Biologist with extensive training in wetland science and ecology restoration. Chad also has professional experience in stream and fish restoration, marine monitoring, mitigation monitoring, and fish and wildlife assessments.

Chad has earned a Bachelor's of Arts degree in Environmental Studies from the University of Washington along with certificates in ecology restoration and wetland science.

For a list of representative projects, please contact him at Grette Associates.

9 REFERENCES

Anderson, P., S. Meyer, P. Olson, and E. Stockdale. 2016. Determining OHWM for Shoreline Management Act Compliance in Washington State. Washington State Department of Ecology, Shorelines and Environmental Assistance Program, Lacey, WA. Ecology Publication # 16-06-029.

Herrera Environmental Consultants, Inc. 2001. Gilliam Creek Basin-StormWater Management Plan. Prepared for the City of Tukwila. March 9, 2001.

Environmental Laboratory (Corps). 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. The National Wetland Plant List: 2016 Wetland Ratings. Phytoneuron 2016-30:1-17. Published 28 April 2016. ISSN 2153 733X.

Natural Resource Conservation Service (NRCS). 2018. United States Department of Agriculture. Web Soil Survey [map online]. Queried October 1, 2018. URL: http://websoilsurvey.nrcs.usda.gov/

U.S. Army Corps of Engineers (Corps). 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)*, ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-10-3. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Fish and Wildlife Service (USFWS). 2018. Wetland Mapper [map online]. National Wetlands Inventory Queried October 1, 2018. URL: http://www.fws.gov/wetlands/Wetlands-Mapper.html Interactive Layer = "Wetlands".

Washington Department of Fish and Wildlife (WDFW). 2018a. PHS on the Web [map online]. Priority Habitats and Species Queried October 1, 2018. URL: http://wdfw.wa.gov/mapping/phs/.

Washington Department of Fish and Wildlife (WDFW). 2018b. SalmonScape [map online]. All SalmonScape Species. Queried October 1, 2018. URL: http://wdfw.wa.gov/mapping/phs/.

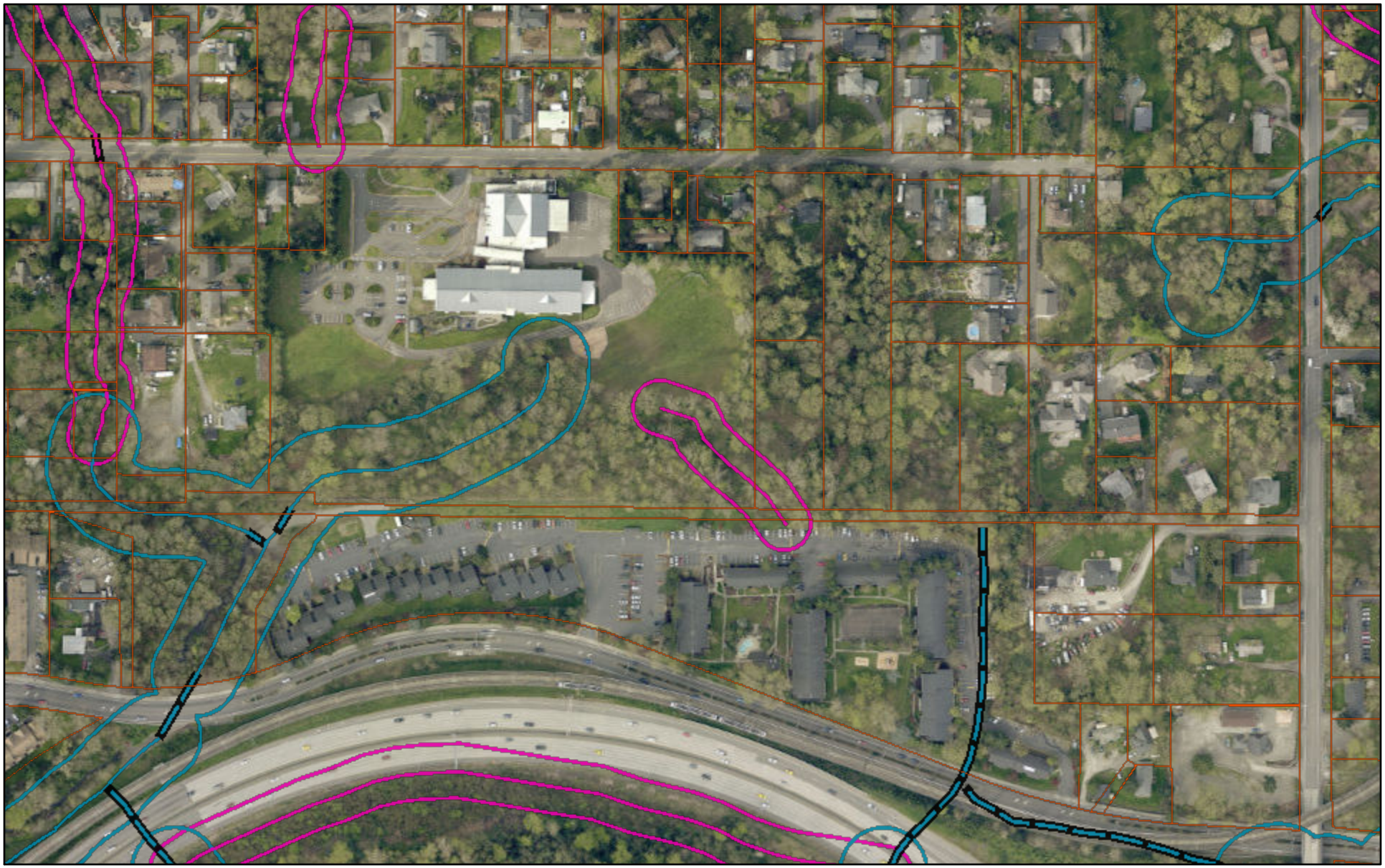
Washington Department of Natural Resources (WDNR). 2018. Forest Practices Application Mapping Tool [map online]. Streams and Water Type Breaks. Queried October 1, 2018. URL: https://fortress.wa.gov/dnr/protectiongis/fpamt/index.html

10022 9TH AVE. CT E - PIERCE COUNTY, WA

WETLAND ANALYSIS REPORT AND HABITAT ASSESSMENT

APPENDIX A: QUERIED DATABASE FIGURES

Thorndyke Elementary School



10/2/2018, 12:20:28 PM

Parcels

StreamBuffers
- 50
- 80
- 100

Streams
- Type 2 Stream
- Type 2 Stream in Pipe
- Type 3 Stream
- Type 3 Stream in Pipe
- Type 4 Stream

1:4,514

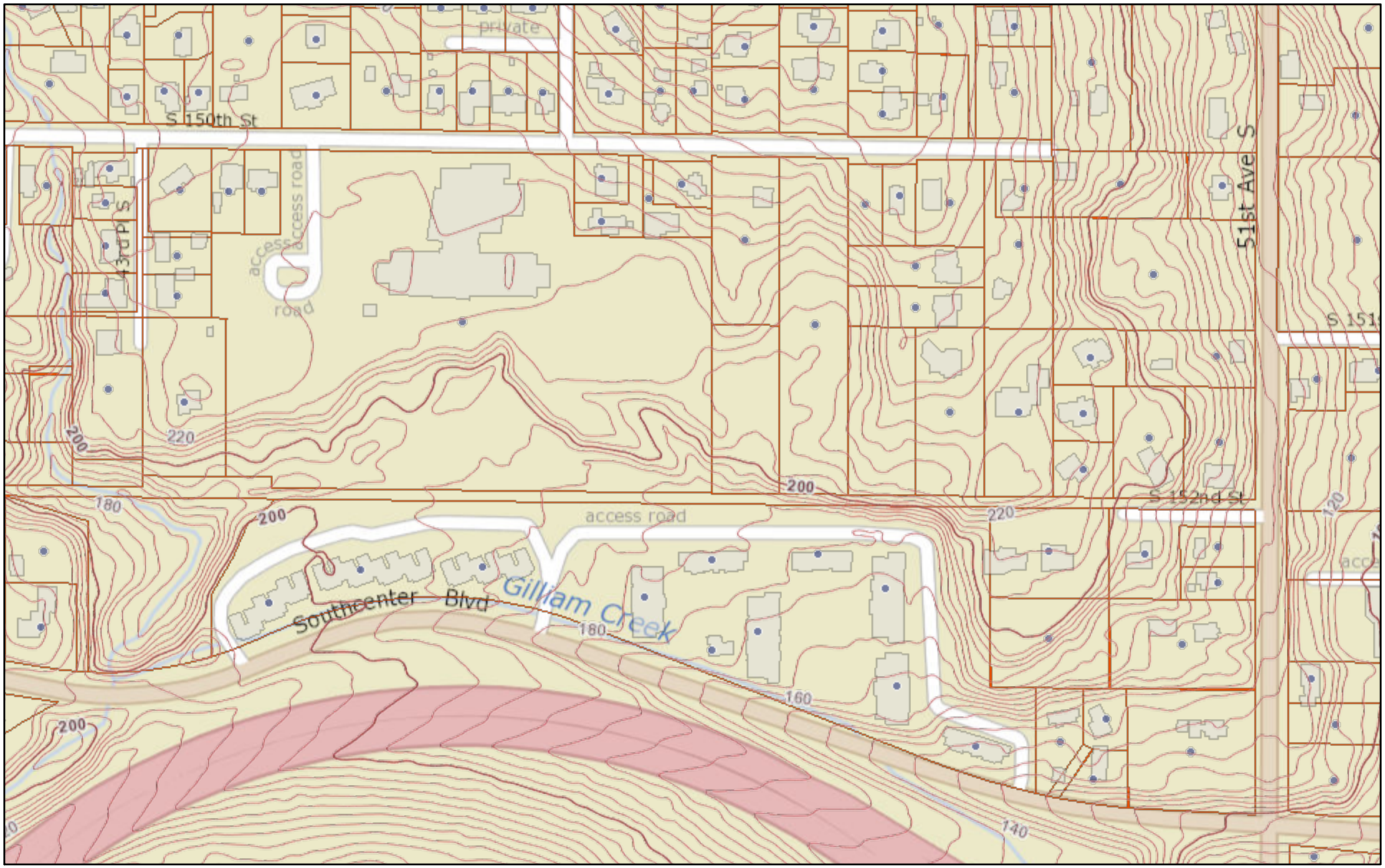
0 0.03 0.05 0.1 mi

0 0.04 0.08 0.16 km

Pictometry International Corp., Tukwila Technology Services, King County

City of Tukwila

Thorndyke Elementary School



10/3/2018, 8:41:48 AM

City Limits

Buildings

Addresses (Tukwila)

Parcels

Potential Annexation Areas

City Limits

1:4,514

0 0.03 0.05 0.1 mi

0 0.04 0.08 0.16 km

Tukwila Technology Services, King County

City of Tukwila

King County iMap

Date: 10/1/2018 Notes:

N

King County GIS Center

U.S. Fish and Wildlife Service
National Wetlands Inventory

Wetlands

October 2, 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.

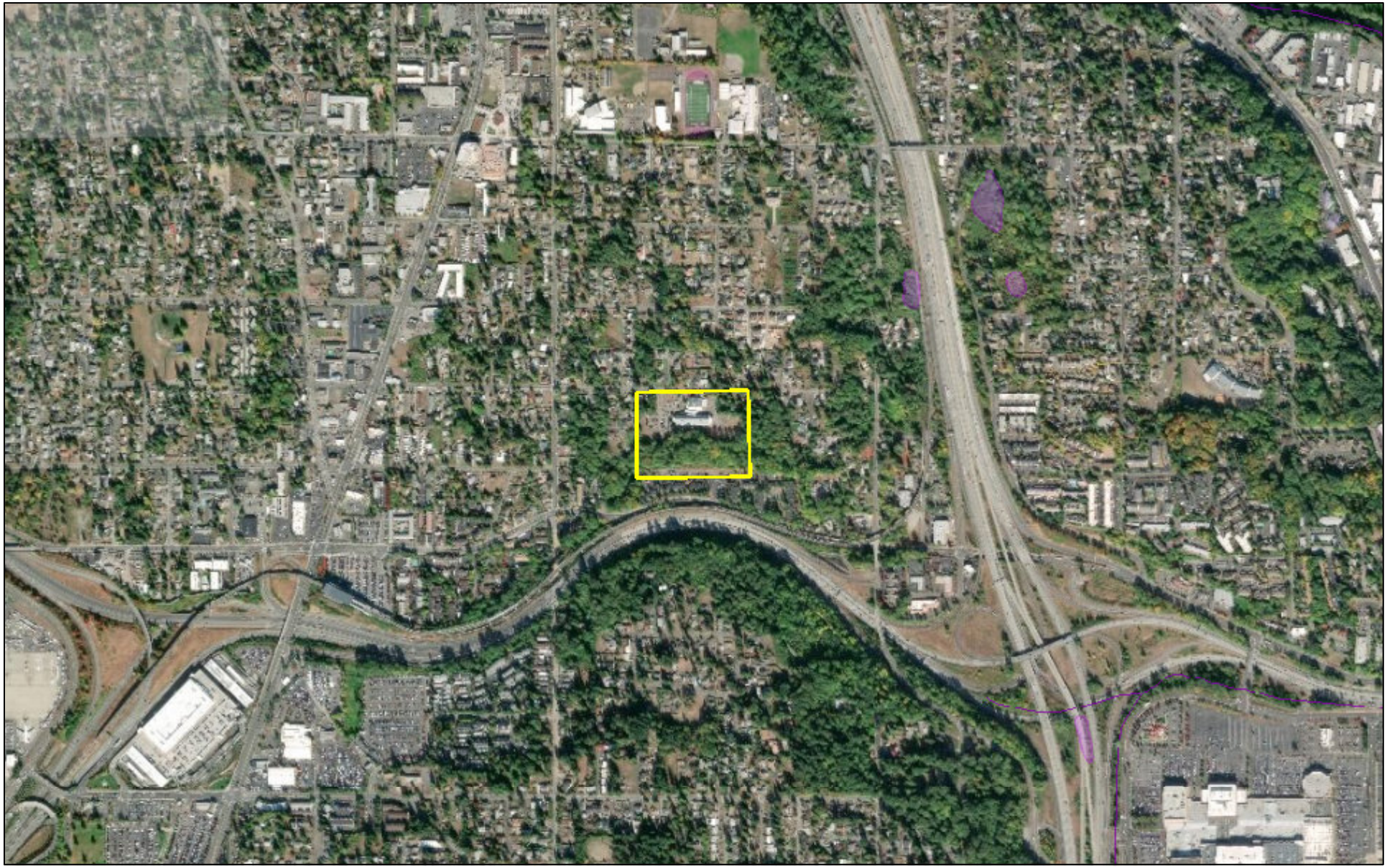
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
PRIORITY HABITATS AND SPECIES REPORT

SOURCE DATASET: PHSPlusPublic
REPORT DATE: 10/01/2018 12.32

Query ID: P181001123150

Common Name	Site Name	Priority Area	Accuracy	Federal Status	Sensitive Data	Source Entity
Scientific Name	Source Dataset	Occurrence Type		State Status	Resolution	Geometry Type
	Source Record	More Information (URL)		PHS Listing Status		
Notes	Source Date	Mgmt Recommendations				

WDFW Test Map



October 1, 2018

PHS Report Clip Area

PT

LN

POLY

AS MAPPED

SECTION

QTR-TWP

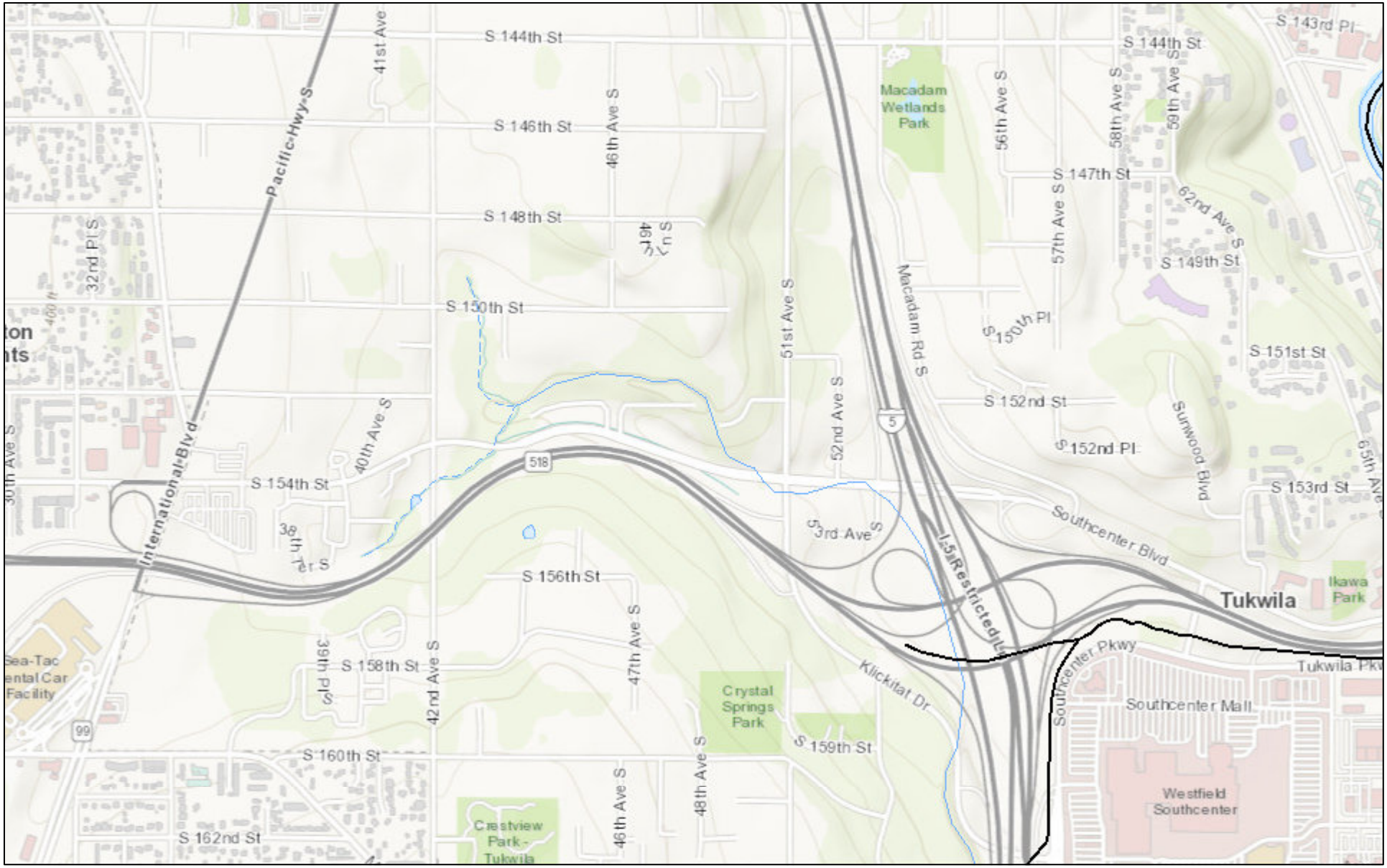
TOWNSHIP

1:19,842

0 0.15 0.3 0.6 mi

0 0.275 0.55 1.1 km

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



October 1, 2018

All SalmonScape Species

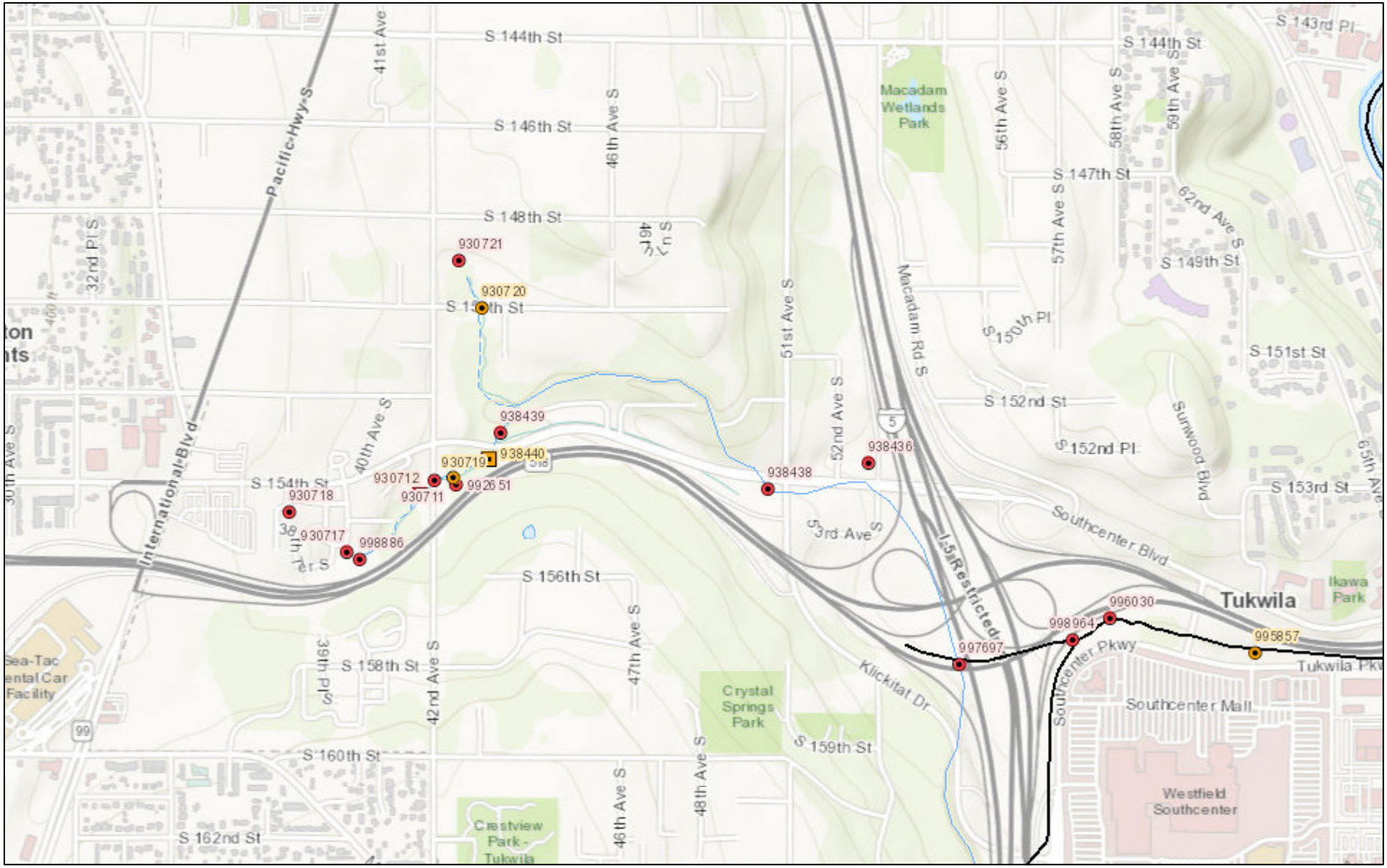
1:18,056

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

USGS/NHD

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS,



October 1, 2018

1:18,056

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Culverts

- Total Blockage
- Total Blockage, Fishway Present
- Partial Blockage
- Partial Blockage, Fishway Present
- Unknown Blockage
- Unknown Blockage, Fishway Present

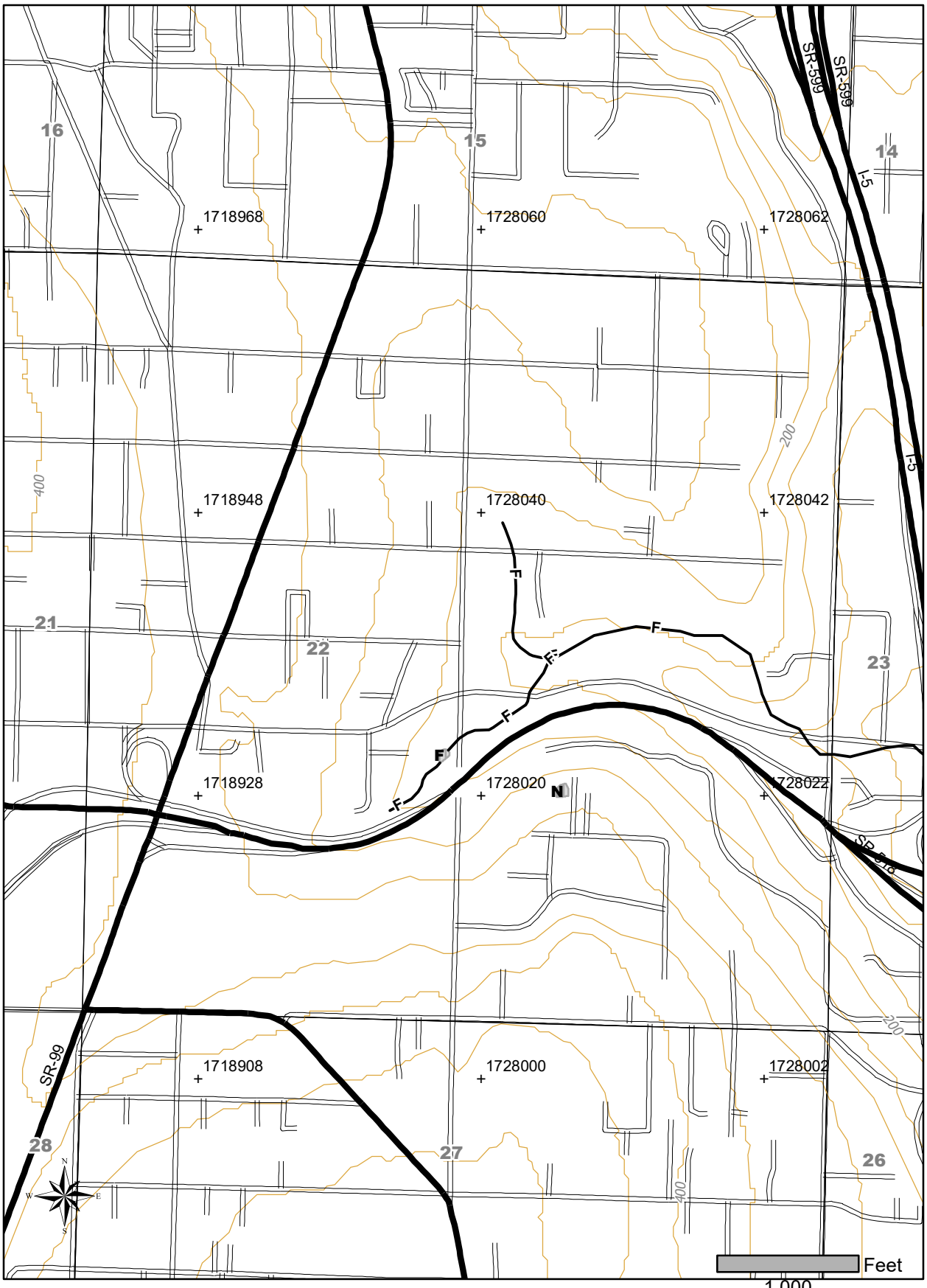
USGS/NHD

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS,

FOREST PRACTICE ACTIVITY MAP

TOWNSHIP 23 NORTH HALF 0, RANGE 04 EAST (W.M.) HALF 0, SECTION 22

Application #: _____



Please use the legend from the FPA Instruction or provide a list of symbols used.

Date: 10/1/2018 Time: 12:27:42 PM
NAD 83
Contour Interval: 40 Feet

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
Seattle, Washington 98121
Telephone: 206.441.9080

in association with

RW Beck
1001 Fourth Avenue, Suite 2500
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

Introduction 1

Existing Conditions in the Gilliam Creek Basin 3

- Drainage Basin Description 3
  - Southcenter Mall Subbasin 3
  - City Hall Subbasin 4
  - I-5 East Subbasin 7
  - I-5 West Subbasin 7
  - Riverton Heights Subbasin 7
  - Crystal Springs Subbasin 8
- Water Quality Conditions 8
  - Previous Water Quality Sampling Data 8
  - Current Water Quality Sampling Data 13
- Drainage Conditions 15
- Fish Habitat Conditions 16
  - Fish Species Presence 16
  - Anadromous and Resident Fish Habitat 16
- Summary of Existing Problems 17

Recommended Capital Improvement Projects and Programmatic Actions 19

- Recommended Improvement Projects 19
- Prioritization of Improvement Recommendations 19
  - Priority Level Determination 23
- Programmatic Actions to Enhance Protection of Gilliam Creek 24
  - Pollution Source Control Program for Targeted Businesses 24
  - BMP Handbooks 26
  - Public Notice of Updates on Basin Plan Implementation 26
  - Locational Signage for Gilliam Creek and Its Tributaries 26
  - Storm Drain Stenciling 27
  - Increased City Staff Resources to Implement Programmatic Actions 27

Funding Options Analysis 29

- Current Stormwater Funding Program 29
  - Stormwater Utility 29
  - Grants and Loans 31
  - Interlocal Coordination 31
  - Permit Fees 31
  - Summary 31
- Secondary Funding Options 32
  - State and Federal Grants and Loans 32
  - Potential Secondary Funding Sources within the City of Tukwila 36
- Summary 41

References 43

Appendix A Water Quality Laboratory Data and Quality Assurance Worksheets
Appendix B Screening of Proposed Improvement Project Alternatives
Appendix C Descriptive Fact Sheets and Supporting Information for Recommended Improvement Projects

Tables

Table 1. Historical Gilliam Creek water quality data....9
Table 2. Water quality values found in Seattle area streams compared to Class A water quality criteria. 10
Table 3. Gilliam Creek water quality sampling results compared to Class A water quality criteria. 14
Table 4. Recommended capital improvement projects for the Gilliam Creek basin. 20
Table 5. Priority level determination for recommended Gilliam Creek improvement projects. 25
Table 6. Stormwater utility year 2000 service rates. 30
Table 7. Comparison of area surface water utility service rates for a typical single-family residence. 30

Figures

Figure 1. Vicinity map of Gilliam Creek drainage basin, Tukwila, Washington....4
Figure 2. Gilliam Creek basin characteristics....5
Figure 3. Water quality monitoring stations in the Gilliam Creek basin....11
Figure 4. Gilliam Creek basin recommended drainage, water quality, and habitat improvement project locations....21

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).

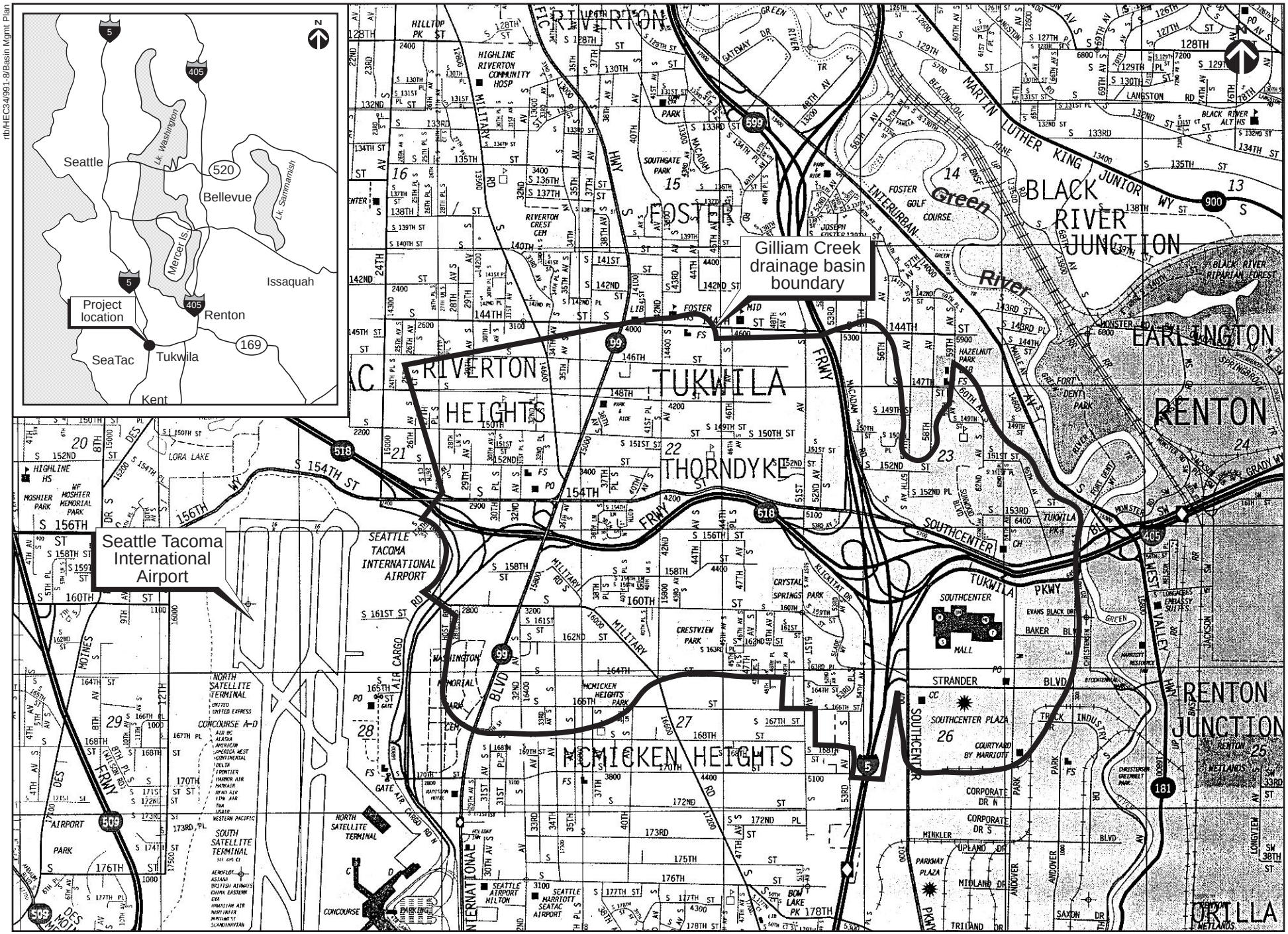


Figure 1. Vicinity of Gilliam Creek drainage basin, Tukwila, Washington.

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.

rtb\HEC34\91-8\Basin Mgmt Plan

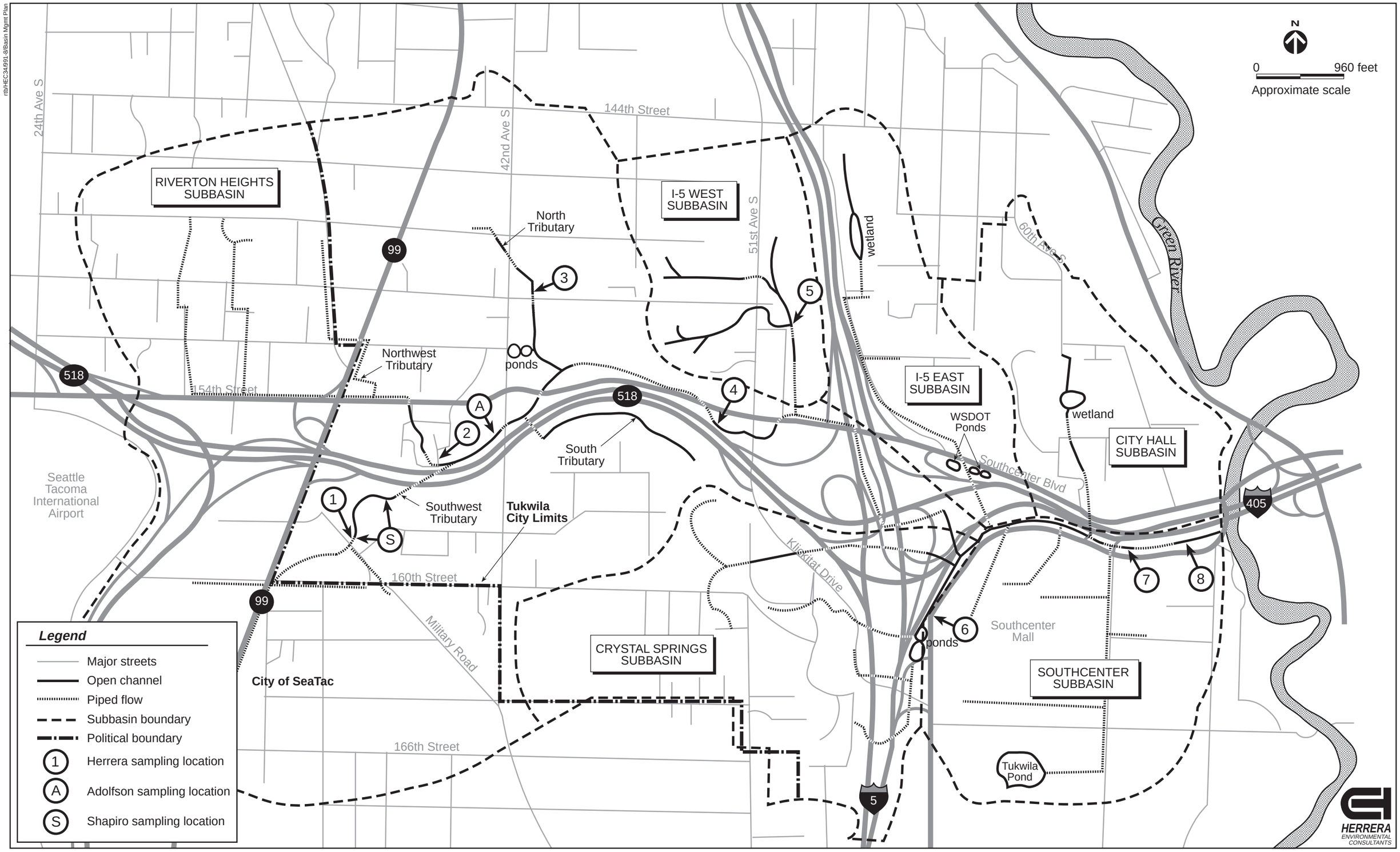


Figure 3. Gilliam Creek water quality monitoring stations.

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.

References

Adolfson. 1995. Gilliam Creek water quality monitoring technical memorandum. Prepared by Adolfson Associates, Inc.

City of Tukwila. 1999. Unpublished data (map of Gilliam Creek watershed) prepared by the Public Works Department, Tukwila, Washington.

Entranco et al. 1997. Riverton Creek stormwater quality management plan. Prepared for city of Tukwila by Entranco, Inc. in association with Taylor Associates, Inc. and Envirovision, Inc.

Herrera. 1996. Fostoria Basin stormwater quality management plan. Prepared for city of Tukwila Department of Public Works by Herrera Environmental Consultants, Inc.

Herrera. 2000. Gilliam Creek basin description of existing conditions and alternatives for improvement. Prepared for city of Tukwila Department of Public Works by Herrera Environmental Consultants, Inc.

KCM. 1986. City of Tukwila, Gilliam Creek basin drainage study. Prepared for city of Tukwila, Tukwila, WA, by KCM Inc., Seattle, WA.

KCM. 1993. City of Tukwila, Surface water management comprehensive plan, Final Report. Prepared for city of Tukwila, Tukwila, WA, by KCM Inc., Seattle, WA.

Metro. 1994. Water Quality of Small Lakes and Streams, Western King County 1990-1993. King County Department of Metropolitan Services, Seattle, WA.

Partee, Ryan. March 11, 1999. Personal communication (conversation with Doug Gresham, Herrera Environmental Consultants, Inc. regarding fish presence in Gilliam Creek). City of Tukwila Public Works Department, Tukwila, Washington.

Perteet. 1994. Design memorandum for Gilliam Creek detention and water quality enhancements. Prepared for city of Tukwila, Tukwila, WA, by Perteet Engineering, Inc.

Shapiro, 1999. Re: Water quality monitoring of the Republic Parking site in Tukwila, Washington. Letter to Rebecca Riesen, S.R.O., by Shapiro & Associates, Inc. March 5, 1999.

Shapiro. 1997. Re: Water quality monitoring of the Republic Parking site in Tukwila, Washington. Letter to Rebecca Riesen, S.R.O., by Shapiro & Associates, Inc. December 19, 1997.

USACE. 2000. Green-Duwamish G.I. Ecosystem Restoration Feasibility Study Project Description and Write-up.

USGS. 1973. Topographic map of Des Moines, Washington. 1:24,000. U.S. Geological Survey.

USGS. 1973. Topographic map of Renton, Washington. 1:24,000. U.S. Geological Survey.

Williams, W.R., R.M. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization. Volume 1: Puget Sound Region. Washington Department of Fisheries.

Wydoski, R.S. and R.R. Whitney. 1979. Inland fishes of Washington. Seattle, WA. and London. University of Washington Press.

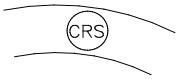
Section 7.0 Attachments

(No Attachments)

Section 8.0 Attachments

Exhibit 8-1 ..... ESC and SWPPS Measures
Exhibit 8-2 ..... ESC Maintenance Report
Exhibit 8-3 ..... Inspection Reports

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).

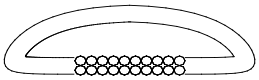
Selection of the Design Storm: In most circumstances, the developed condition 2-year peak flow using the approved model with 15-minute time steps is sufficient for calculating surface area for ponds and traps and for determining exemptions from the sediment retention and surface water collection requirements

(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.

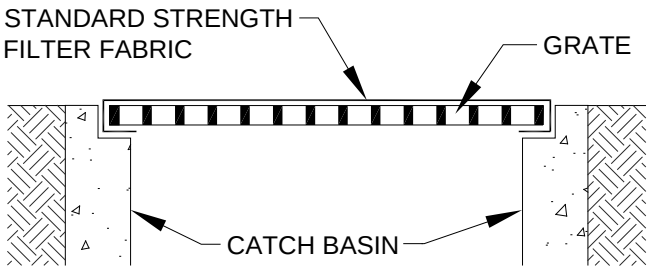
Design and Installation Specifications

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:

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

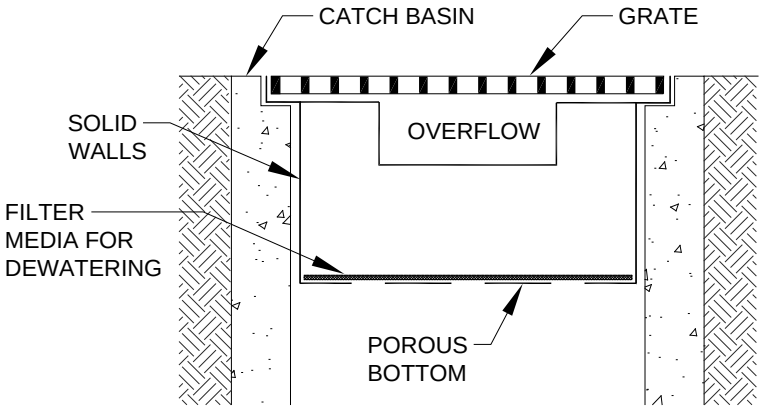
where Q_2 = Design inflow (cfs) from the contributing drainage area based on the developed condition 2-year or 10-year peak discharge using the approved model with 15-minute time steps as computed in the hydrologic analysis. The approved model 10-year 15-minute peak flow shall be used if the project 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

Exhibit 10-1 ..... Storm Facility Maintenance Checklist
Exhibit 10-2 ..... Maintenance Requirements for Flow Control, Conveyance, and Water Quality Facilities

STORM FACILITY MAINTENANCE CHECKLIST

Property: Thorndyke Elementary School
Property Owner: Tukwila School District
Property Address: 4415 S 150th St, 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

Civil Engineers
Structural Engineers
Landscape Architects
Community Planners
Natural Resource Ecologists
Land Surveyors
Neighbors

TACOMA
2215 North 30th Street
Suite 300
Tacoma, WA 98403-3350
253.383.2422 TEL
253.383.2572 FAX

SEATTLE
1200 6th Avenue
Suite 1620
Seattle, WA 98101-3117
206.267.2425 TEL
206.267.2429 FAX

SPOKANE
827 West First Avenue
Suite 301
Spokane, WA 99201-3912
509.252.5019 TEL
509.315.8862 FAX

www.ahbl.com

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.