PRELIMINARY TIR

BURKE-GILMAN TRAIL REDEVELOPMENT IN LAKE FOREST PARK

July 7, 2006

Prepared for:

MacLeod Reckord
231 Summit Avenue East
Seattle, WA 98102

7/7/06

AMIE L. BROADSWORD
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EXPIRES: 5/2/07

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MEMORANDUM

Date: July 27, 2006

To: Kristen Lohse at MacLeod Reckord

From: Amie Broadsword

Subject: **Burke-Gilman Trail Redevelopment: Addendum to Preliminary TIR**

The Preliminary TIR dated July 7, 2006 for the Burke-Gilman Trail Redevelopment in Lake Forest Park has a misprint that is carried throughout the report. The proposed trail width is listed with 8 feet of asphalt instead of the proposed 12 feet shown on the plans. This misprint does not affect the pollution generating impervious (PGIS) areas presented in Table 1 of the report. These areas were measured in CAD using the correct trail width. The conclusions of the report are valid.

The following corrections shall be made when the TIR is finalized during the next phase of design:

- Page 2, paragraph 2. The number 8 shall be corrected to 12 in two places.
- Page 24. The number 8 shall be corrected to 12.
- Figure 4. Trail shall be corrected to show 12-foot wide paved section.
- Figure 5. Trail shall be corrected to show 12-foot wide paved section.
- Page 18, paragraph 2. The number 12 shall be corrected to 16.

Amie Broadsword, P.E.
Project Engineer
PACE Engineers, INC.

7-27-06

AMIE L. BROADSWORD
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I. PROJECT OVERVIEW

The Burke-Gilman Trail Redevelopment project consists of widening the existing Burke-Gilman Trail through the City of Lake Forest Park. The City of Lake Forest Park is the permitting authority for this project. The 2005 King County Surface Water Design Manual ('05 KCSWDM) has been adopted as the drainage manual for this City and has been used for the design of drainage improvements to the trail.

The proposed trail section consists of an 8-foot wide asphalt paved trail, with a 3-foot gravel shoulder on the downstream (lakeside) of the trail, and a 1-foot gravel shoulder on the upstream side of the trail. Intersections shall be resurfaced with an 8-foot wide strip of concrete to delineate the trail location where it crosses local access streets. The overall length of the proposed improvements is approximately 2.2-miles and begins and NE 145th Street and continues northerly and easterly through the City of Lake Forest Park to the boundary with the City of Kenmore at Log Boom Park. Trail widening in some areas will require cuts into existing soils and also some areas of fill. Figures 4 and 5 show schematic design of cut and fill trail sections.

The existing soils per the Preliminary Geotechnical Investigation (attached in Appendix C) consist of dense to very dense, glacially consolidated deposits forming the steep slopes, with loose to medium dense deposits derived from post-glacial erosion and landsliding forming colluvium in the low areas. The existing trail is built on top of an old railroad track alignment, which Is built on cuts into the dense soils and fills built over dense soils, as well as over loose colluvium, alluvium and beach deposits.

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FIGURE 1: TIR Worksheet

King County Department of Development and Environmental Services

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER	Part 2 PROJECT LOCATION AND DESCRIPTION
Project Owner: **King County** Address: **xxx** Phone: **xxx** Project Engineer: **Amie Broadsword, P.E.** Company: **PACE Engineers, Inc.** Address/Phone: **1601 2nd Ave. Suite 1000 Seattle, WA (206) 441-1855**	Project Name: **Burke Gilman Trail Redevelopment** Location Township: **26N** Range: **04** Section: **10,11,15**

Part 3 TYPE OF PERMIT APPLICATION	Part 4 OTHER REVIEWS AND PERMITS	
☐ Subdivision	☐ DFW HPA	☐ Shoreline Management
☐ Short Subdivision	☐ COE 404	☐ Rockery
X **Grading and Drainage**	☐ DOE Dam Safety	☐ Structural Vaults
☐ Commercial	☐ FEMA Floodplain	☐ Other
☐ Other	x COE Wetlands	

Part 5 SITE COMMUNITY AND DRAINAGE BASIN
Community: **Lake Forest Park**
Drainage Basin: **West Lake Washington – Lake Forest Park**

Part 6 SITE CHARACTERISTICS	
☐ River _____	☐ Floodplain _____
X **Streams-McAleer and Lyons Creek**	X **Wetlands-Mapped**
X **Critical Stream Reach-McAleer and Lyons**	X **Seeps/Springs-Present along trail**
X **Depressions/Swales**	X **High Groundwater Table**
X **Lake-Within ¼ mile of Lake Washington**	☐ Groundwater Recharge _____
X **Steep Slopes**	☐ Other _____

FIGURE 1: TIR Worksheet (cont.)

Part 7 SOILS

Soil Type	Slopes	Erosion Potential	Erosive Velocities
Various Types of dense to very dense glacially consolidated deposits forming steep slopes.	**Steep**	**High**	**Fast**
Also loose colluvium, alluvium and beach deposits.	**Flat**	**Slight**	**Slow**

☐ Additional Sheets Attached

Part 8 DEVELOPMENT LIMITATIONS

	REFERENCE	LIMITATION/SITE CONSTRAINT
X	**Ch. 4 – Downstream Analysis**	**Protect offsite downstream properties from erosion.**
☐		
☐		
☐		
☐		

☐ Additional Sheets Attached

Part 9 ESC REQUIREMENTS

MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION	MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION
X **Sedimentation Facilities**	X **Stabilize Exposed Surface**
X **Stabilized Construction Entrance**	X **Remove and Restore Temporary ESC Facilities**
X **Perimeter Runoff Control**	X **Clean and Remove All Silt and Debris**
X **Clearing and Grading Restrictions**	X **Ensure Operation of Permanent Facilities**
X **Cover Practices**	X **Flag Limits of SAO and open space preservation areas**
X **Construction Sequence**	☐ Other
☐ Other	

FIGURE 1: TIR Worksheet (cont.)

Part 10 SURFACE WATER SYSTEM

- X Grass Lined Channel
- X Pipe System
- X Open Channel
- ☐ Dry Pond
- ☐ Wet Pond
- ☐ Tank
- ☐ Vault
- ☐ Energy Dissipater
- X Wetland
- X Stream
- ☐ Infiltration
- ☐ Depression
- X Flow Dispersal
- ☐ Waiver
- ☐ Regional Detention

Method of Analysis

KCRTS v.4.42b

Compensation/Mitigation of Eliminated Site Storage

_____

Brief Description of System Operation

Site is eligible for direct discharge to Lake Washington, and will utilize existing manmade conveyance paths from the trail to the lake. To the extent possible, runoff will be directed to existing open vegetated swales, prior to entry into piped storm drainage system. This site is exempt from water quality treatment because all threshold discharge areas have less than 5,000 square feet of PGIS proposed. Since the trail itself is only subject to intermittent vehicular use for maintenance activities, it is non-PGIS pre the '05 KCSWDM. The only areas considered PGIS are where the trail improvements intersect local access streets.

Facility Related Site Limitations

Reference	Facility	Limitation
Core Req. 3	**Direct Discharge Exemption**	
Core Req. 8	**Waived with Surface Area Exemption #1**	

Part 11 STRUCTURAL ANALYSIS

- ☐ Cast in Place Vault
- X Retaining Wall
- ☐ Rockery > 4' High
- ☐ Structural on Steep Slope
- ☐ Other:

Part 12 EASEMENTS/TRACTS

- X **Drainage Easement / Tract**
- X **Access Easement**
- X **Native Growth Protection Easement**
- ☐ Tract
- ☐ Other

Part 13 SIGNATURE OF PROFESSIONAL ENGINEER

I or a civil engineer under my supervision has visited the site. Actual site conditions as observed were incorporated into this worksheet and the attachments. To the best of my knowledge the information provided here is accurate.

David L. Broadbent 7/7/06

Signed/Date

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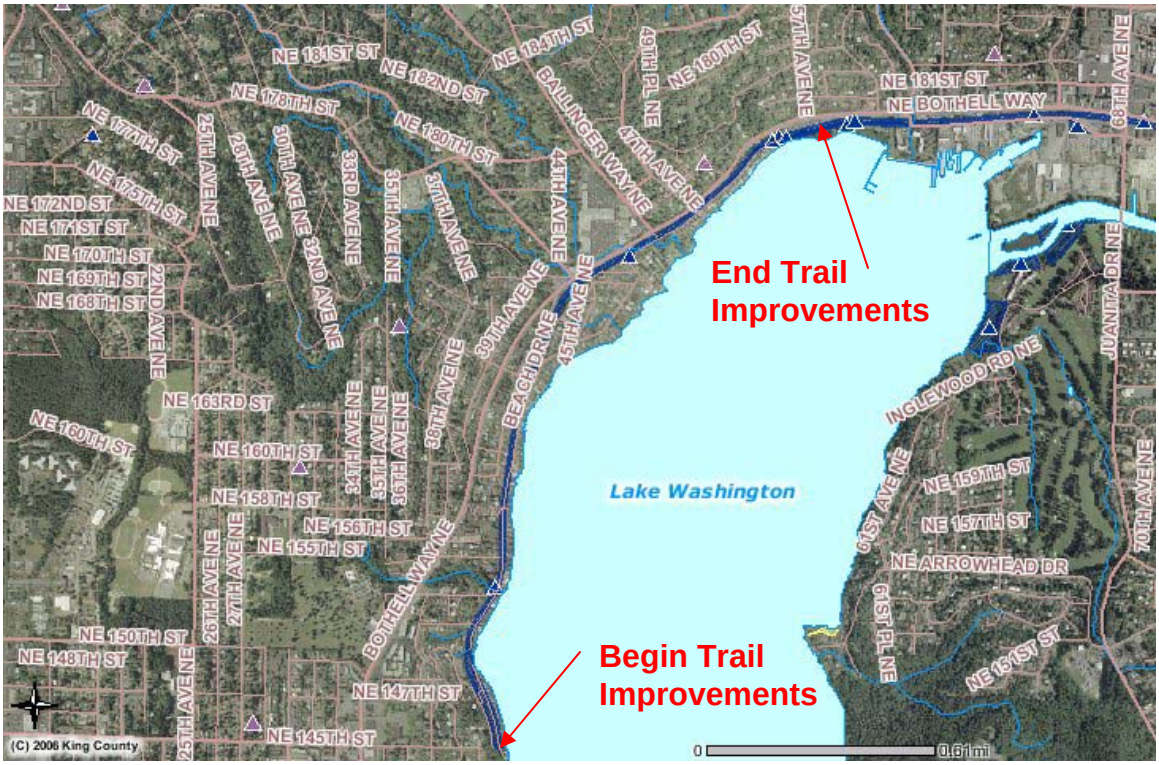
FIGURE 2: SITE LOCATION



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Drainage Basins Map
1 inch equals 300 feet
N
McMeer / Lyon Creek Basins
Lake Forest Park
Shoreline
Kenmore
Seattle
Lake Washington
McMeer Creek
Lyon Creek
1
1A
2
3
4
5
6
7
8
8A
8B
8C
9
10
11
11A
11B
12
13
Legend
Ex. Culvert
Ex. Ditch
Ex. Storm Pipes
Creeks
10' Contours
Drainage Basins
Burke Gilman Trail
City Limits

FIGURE 3

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II. CONDITIONS AND REQUIREMENTS SUMMARY

Conditions and requirements for this project include all eight Core Requirements listed in the 2005 King County Surface Water Design Manual (KCSWDM) as adopted by the City of Lake Forest Park.

Core Requirements (KCSWDM Section 1.2)

Core Requirement #1: Discharge at the Natural Location
This site has multiple discharge locations due to the linear nature of the project area, which runs parallel to the shoreline of Lake Washington along an old railroad alignment. Two major streams cross the project trail section, McAleer and Lyons Creeks. Drainage will be maintained at the current discharge locations.

Core Requirement #2: Offsite Analysis
A level one downstream analysis is included in this report. Refer to Section III: Offsite Analysis for a more detailed description.

Core Requirement #3: Flow Control
This site is using a direct discharge exemption, as all runoff discharges directly to Lake Washington, a major receiving water body. Flow control BMPs are to be utilized to further attenuate flows. Refer to Section IV: Flow Control and Water Quality Facility Analysis and Design for a more detailed description.

Core Requirement #4: Conveyance System
The conveyance system has been designed to collect and convey the 25-year peak flow. Refer to Section V: Conveyance System Analysis and Design for a more detailed description.

Core Requirement #5: Erosion and Sediment Control
Much of the project site is located in areas that are subject to erosion and landslide hazards. The southern portion of the trail has steep slopes both upstream and downstream of the trail. Moving northerly along the trail, the slopes flatten out near the McAleer and Lyons Creek crossings. Further north and east of those crossings, there are again steep slopes upstream of the trail, but topography is relatively flat on the lakeside of the trail. A temporary erosion and sediment control (TESC) plan will be submitted with the final trail redevelopment plans to limit and mitigate for erosion and sedimentation during construction. A Stormwater Pollution Prevention Plan (SWPPP) shall also be prepared for this project and submitted to the Washington State Department of Ecology. Refer to Section VIII: ESC Analysis and Design for a more detailed description of erosion and sediment control measures.

Core Requirement #6: Maintenance and Operations

The proposed drainage improvements require an operations and maintenance manual. Refer to Appendix A: Operations and Maintenance Manual.

Core Requirement #7: Financial Guarantees and Liability

The owner and developer, King County, will post financial guarantees and liabilities, as required.

Core Requirement #8: Water Quality

The project site is exempt from water quality treatment per the Surface Area Exemption. Refer to Section IV: Flow Control and Water Quality Facility Analysis and Design for a more detailed description.

III. OFFSITE ANALYSIS

The analysis consists of information and data obtained through site visit observations and research of King County and City of Lake Forest Park resources.

Task 1. Study Area Definition and Maps

For the purpose of task 2 below, the study area shall extend 1 mile downstream of the proposed project discharge location, and also includes the upstream offsite area tributary to the site. For purposes of tasks 3, 4, and 5, the study area shall extend downstream to a point on the drainage system where the proposed project site constitutes a minimum of 15% of the total tributary drainage area, but not less than ¼ mile. This project will not produce backwater effects upstream of the site, and therefore the upstream area was excluded from tasks 3 and 4 of this offsite analysis.

The 2.2-mile stretch of trail is located on an old railroad grade that runs parallel to the shore of Lake Washington. The project area is entirely contained within the City of Lake Forest Park and starts at 145th and extends northerly and easterly along the shoreline to Tracy Owen Station (Log Boom Park) at the City boundary with Kenmore. The site spans several sections including 10, 11, and 15 of Township 26N, Range 04 East. For general location, see Figure 2: Site Location. The study area for the downstream analysis is shown in Figure 3: Drainage Basins.

Task 2. Resource Review

A resource review was conducted to determine potential problems downstream of the project site. The following is a list of references used in gathering information for the downstream analysis.

- King County iMAP Data – iMAP data
- Flood Insurance Rate Maps (FIRM) No's. 53033C0331 F, 53033C0032 F, 53033C0043 F, and 53033C0044 F. Review of the FIRMs indicates that the subject site is located in an area determined to be outside of the 500-year floodplain. (Source http://msc.fema.gov)
- USGS Mapping

Task 3. Field Inspection

A downstream analysis was performed to assess potential offsite drainage impacts associated with development of the project site, and to propose appropriate mitigations of those impacts. The primary discharge locations from the trail to Lake Washington were evaluated. Many of the outfalls were on private property and were not able to be inspected. Culvert crossings of the trail were inspected.

Task 4. Drainage System Description and Problem Description

Drainage System Description

The Burke-Gilman Trail follows an abandoned railroad grade and is nearly flat for the 2.2-mile stretch of the proposed redevelopment project. The trail is generally located at the toe of a steep slope, except within the McAleer and Lyon Creek basins where the surrounding topography is mainly flat upstream and gently sloping toward Lake Washington on the downstream side.

The existing conveyance system along the Burke-Gilman Trail is made up of a network of drainage ditches running parallel to the trail on the upstream side, interconnected with cross culverts which convey seepage and runoff across the trail to Lake Washington. Runoff and seepage that makes its way to these culvert crossings is generated upstream of the trail and is conveyed to the trail in a number of ways, including storm drainage piping, manmade ditches and natural drainage courses. Surface water runoff originates from rainfall and other precipitation falling within the drainage basin. Impervious surfaces such as roadways and roofs contribute to the amount of runoff generated in each drainage basin. As part of the proposed redevelopment and widening of the trail, the existing cross culverts were analyzed to determine if they have adequate capacity to convey flows across the trail, and prevent flooding of the trail.

There are 14 drainage basins associated with 17 culvert crossings of the Burke-Gilman Trail. In addition, there are 2 bridge crossings that convey McAleer and Lyon Creeks under the trail, that are part of a larger basin area not included in the PACE analysis. These stream basins have been studied extensively in the past by King County. As a result of these studies, several CIP projects have been constructed to reduce flooding. Further analysis based on a regional drainage basin study may be required to address predicted peak flows and conveyance capacity of the bridge crossings under the trail and is not part of this study. For an analysis of conveyance capacity of the existing culverts, see Appendix B, Drainage Analysis.

Problem Descriptions

There are a number of existing problems along the trail. Near the south end there is a history of landslides and erosion, both on the upstream and downstream side of the trail. Also, the trail in this area generally sits at the toe of a steep slope. Water from both seeps and surface water tends to collect at the toe of the slope adjacent to the trail. Some minor flooding of the trail has occurred as a result, with ponding of water generally on the upstream side of the trail. Additionally, adjacent property owners have identified several drainage problems through the public meeting process. Areas of concern identified by property owners include:

- Landslide issues west of the trail near 15208 38th Place NE
- Inadequate drainage between 15550 and 15524 Beach Drive NE
- Concerns about drainage at 16835 Beach Drive NE
- Drainage problems at 17729 Beach Drive NE
- Drainage from trail damages road, even during summer and groundwater drains under trail causing property damage at 17753 Beach Drive NE

Task 5. Mitigation of Existing or Potential Problems

Seeps and surface water runoff contribute water to the ditches and culverts associated with the existing trail. Due to steep slopes in the vicinity and existing conveyance that is at some points inadequate, there are some existing drainage, erosion, and landslide problems associated with the trail. In order to address these problems, the geotechnical consultant shall recommend mitigation for the existing landslide problems and the civil plans will incorporate drainage recommendations per the geotechnical report. This will likely include drainage elements at the toe of slope and tight-lining of wall drains to an appropriate discharge location. BMPs including surface swales for conveyance and attenuation of flows shall be utilized to the fullest extent practicable. In areas where there is not sufficient space to construct a surface swale to receive hillside and trail runoff, a shallow surface swale shall be constructed over a trench drain system. See Figure 4 for a typical shallow ditch section with trench drain. This project will not aggravate existing problems, and in general seeks to improve the trail over and above the existing condition.

IV. FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

Flow control and water quality treatment for the project are subject to the requirements of the 2005 King County Surface Water Design Manual ('05 KDSWDM). The site is exempt from both flow control and water quality treatment. See Parts D and E of this section for more information on how this project meets exemption criteria listed in the '05 KCSWDM.

Existing Site Hydrology (Part A)

The existing site hydrology is described in detail in Appendix B of this report, within the April 17, 2005 Drainage Analysis. In all, 14 drainage basins draining to culvert crossings were identified. Some basins are drained by more than one culvert, and therefore there are fewer basins than culvert crossings. See Figure 3, Drainage Basins Map for basin and culvert identification.

The existing soils per the Preliminary Geotechnical Investigation (attached in Appendix C) consist of dense to very dense, glacially consolidated deposits forming the steep slopes, with loose to medium dense deposits derived from post-glacial erosion and landsliding forming colluvium in the low areas. The existing trail is built on top of an old railroad track alignment, which is built on cuts into the dense soils and fills built over dense soils, as well as over loose colluvium, alluvium and beach deposits.

Developed Site Hydrology (Part B)

The proposed improvements will not significantly change the existing hydrology of the site. New conveyance elements are planned along the trail to improve collection of trail and hillside runoff. The existing cross culverts will be utilized the extent possible. Existing cross culverts that have been identified as under capacity in the April 17th Drainage Analysis will be upgraded as necessary to convey runoff.

Performance Standards (Part C)

The subject site is located within the City limits of Lake Forest Park, but is owned by King County and as such subject to King County stormwater requirements. Performance standards are taken from the '05 KCSWDM. However, the site is exempt from both flow control and water quality treatment per exemption criteria given in the '05 KCSWDM. The performance standards are listed for reference as follows.

Basic Water Quality Treatment
Basic Water Quality performance goals are to remove 80 percent of total suspended solids (TSS) for flows or volumes up to and including the water quality design flow or volume. The water quality design flow is defined as 60% of the developed two-year peak flow rate as determined using the KCRTS model with 15-minute time steps calibrated to site conditions.

Conservation Flow Control
Conservation Flow Control applies the historic Level 2 flow control standard, which matches historic durations for 50% of the 2-year through 50-year peaks and matches historic 2- and 10-year peaks, if no drainage problems are identified. More stringent controls are required if drainage problems are identified downstream of the site

Flow Control System (Part D)

Per the 2005 King County Surface Water Design Manual, this project is eligible for a direct discharge exemption from flow control. Criteria for this exemption is listed in section 1.2.3, page 1-30 of the manual. Lake Washington is a major receiving water body, and may receive direct discharge of surface water runoff. As such, no flow control facilities have been designed. Flow control BMPs will be used to the extent practicable to attenuate flows prior to discharging to Lake Washington.

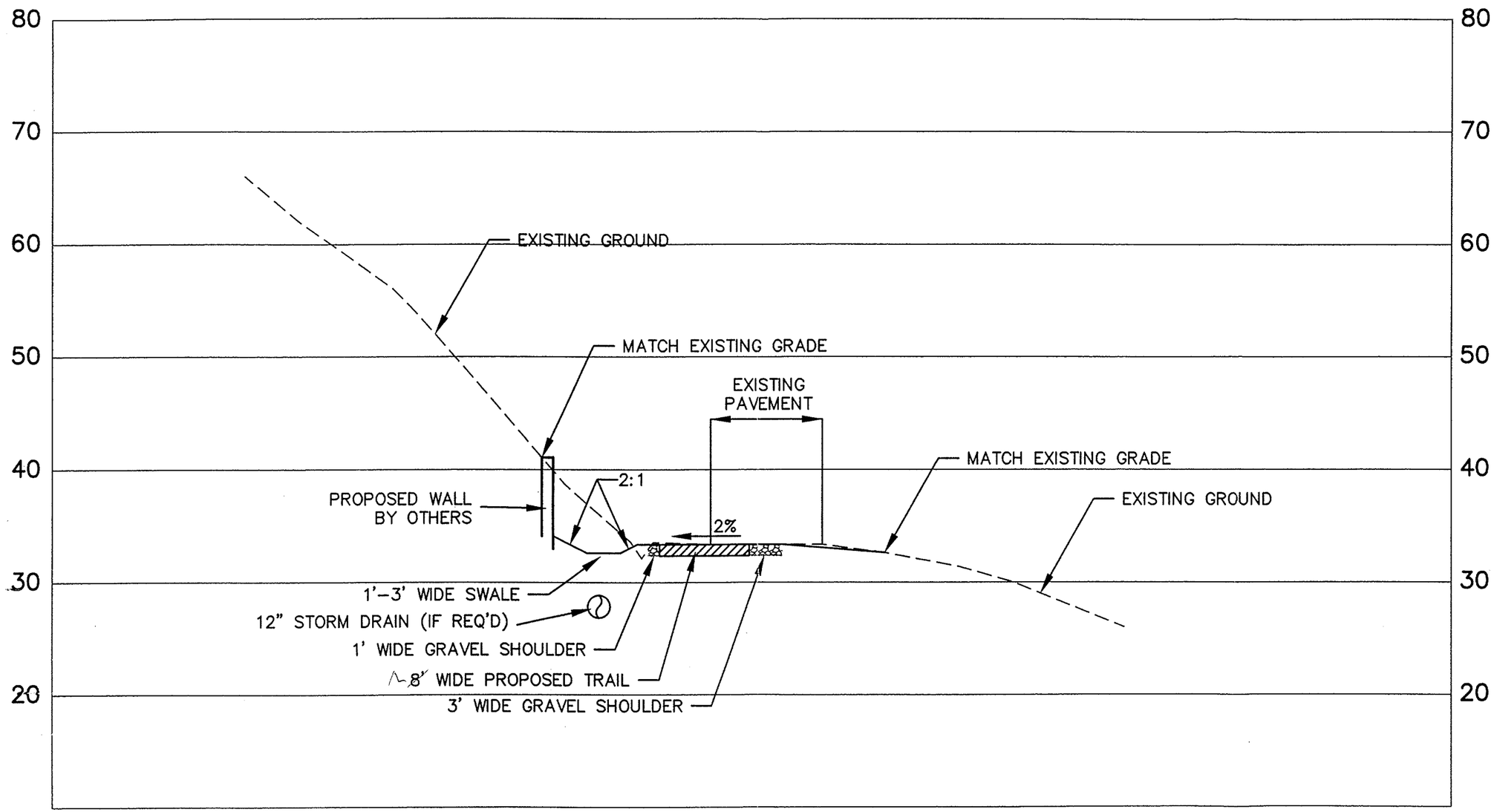
Water Quality System (Part E)

Per the definition given on page 15 of the definitions section of the '05 KCSWDM, the Burke-Gilman Trail is not a pollution generating impervious surface (PGIS). However, there are nine intersection crossings that will be improved, which include the replacement of PGIS. The intersections and their corresponding PGIS with in each basin can be seen in Table 1 on page 14.

Basin	Intersection	PGIS per Intersection (Sq. Ft.)	Total PGIS per Basin (Sq. Ft.)
1A	None	0	0
1	None	0	0
2	None	0	0
3	NE 165th St.	1,031	1,031
4	None	0	0
5	NE 175th Pl.	342	342
6	Res. Drive	432	953
	Res. Drive	521	
7	NE 155th St.	669	669
8	NE 153rd St.	617	913
	NE 155th St.	296	
9	NE 151th St.	2,141	2,141
10	None	0	0
11	NE 147th St.	522	522
12	None	0	0
13	None	0	0

Table 1 – Trail Intersection PGIS

The total amount of proposed replaced PGIS has been estimated as 6,571 square feet. For purposes of estimating, 5-feet on either side of the proposed 8-foot wide trail was included in the PGIS estimate. This number takes into account grading improvements that will be necessary to match the trail grade to the existing grade on the uphill and downhill sides at each crossing. This site is eligible for the Surface Area Exemption (#1) from water quality treatment because no basin along the length of the project has greater than 5,000 square feet of replaced PGIS. Conservatively, each basin is larger than an individual threshold discharge area, which is used to determine eligibility for the exemption. Water quality BMPs will be used to the extent practicable to prevent pollutants from entering the piped storm system and discharging to Lake Washington.



DESIGNED AMB DRAWN SCM CHECKED AMB	PACE An Engineering Services Company 1601 2nd Avenue Suite 1000 Seattle, WA 98101 p. 206.441.1855 | f. 206.448.7167 Civil | Structural | Planning | Survey paceengrs.com	**MACLEOD RECKORD** 231 SUMMIT AVENUE E. SEATTLE, WA 98102	DATE 7/7/06 SCALE 1"=10'(H) 1"=10'(V)	**BURKE-GILMAN TRAIL REDEVELOPMENT** FIGURE 4 – TYPICAL TRAIL SECTION	JOB NUMBER **06601.00** DWG NO. SECTIONS SHEET **FIG 4**

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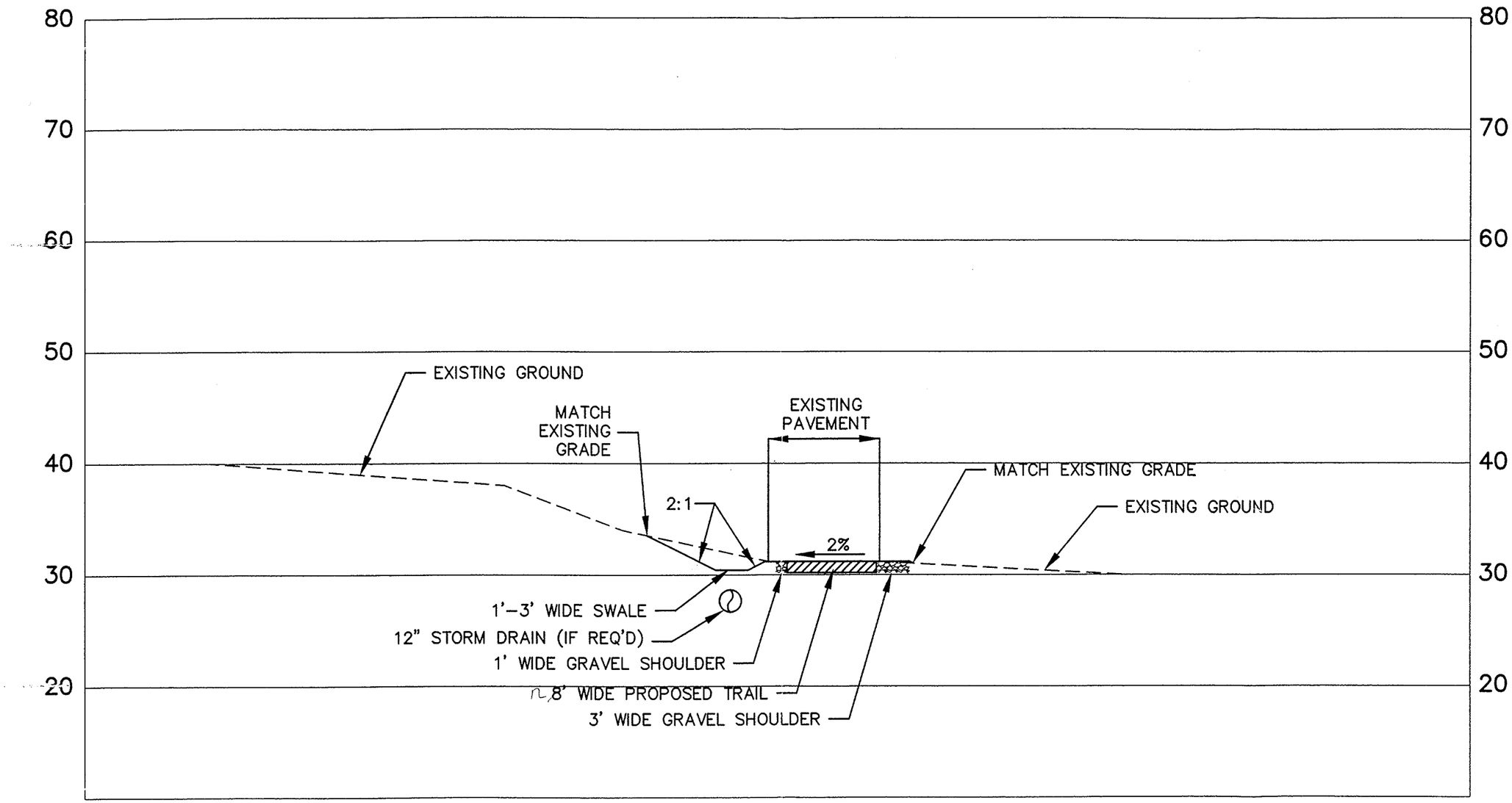

DESIGNED AMB DRAWN SCM CHECKED AMB	PACE An Engineering Services Company 1601 2nd Avenue Suite 1000 Seattle, WA 98101 p. 206.441.1855 | f. 206.448.7167 Civil | Structural | Planning | Survey paceengrs.com	**MACLEOD RECKORD** 231 SUMMIT AVENUE E. SEATTLE, WA 98102	DATE 7/7/06 SCALE 1"=10'(H) 1"=10'(V)	**BURKE-GILMAN TRAIL REDEVELOPMENT** FIGURE 5 –TYPICAL TRAIL SECTION	JOB NUMBER **06601.00** DWG NO. SECTIONS SHEET **FIG 5**

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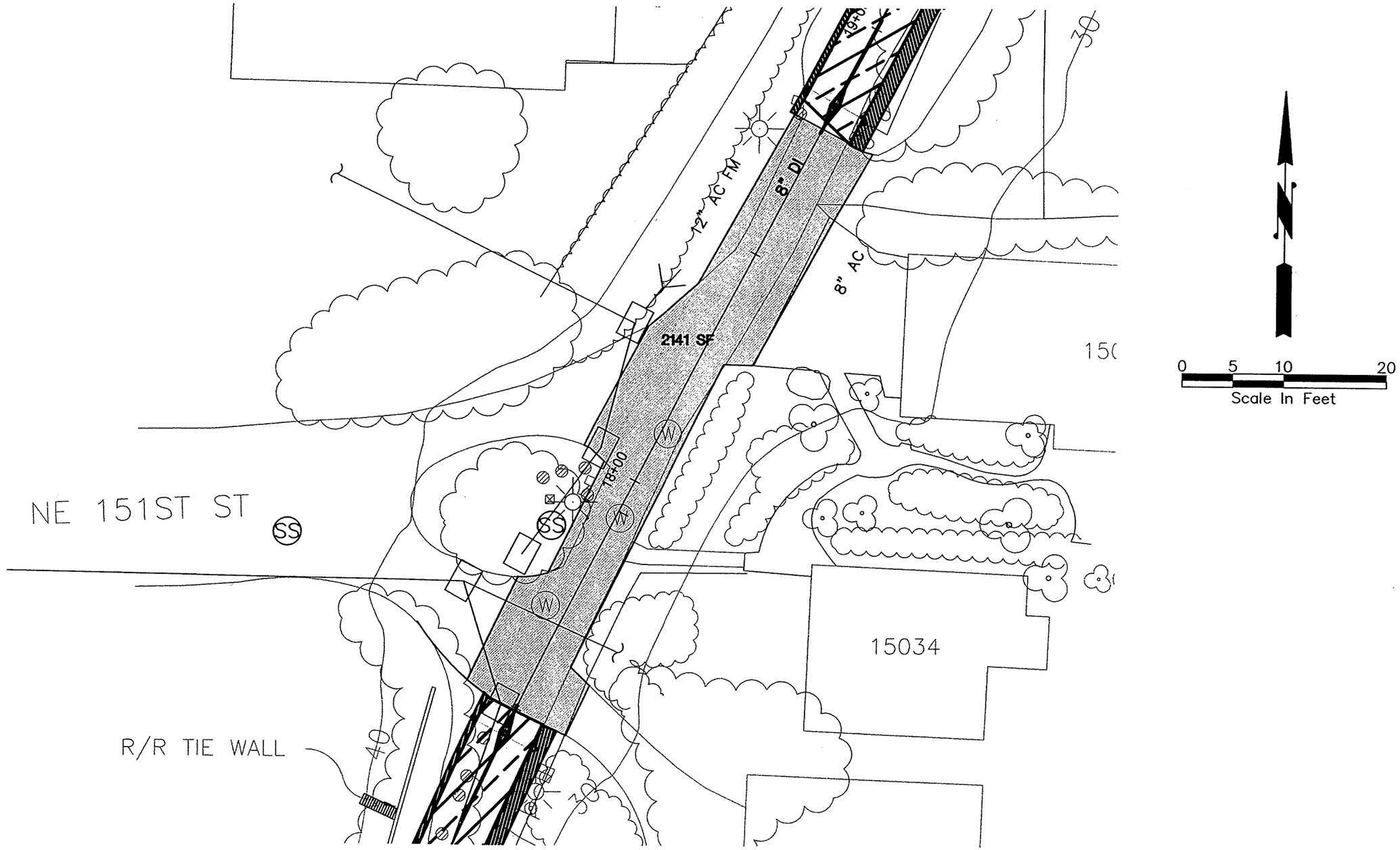

DESIGNED AMB DRAWN SCM CHECKED AMB	PACE An Engineering Services Company 1601 2nd Avenue Suite 1000 Seattle, WA 98101 p. 206.441.1855 | f. 206.448.7167 Civil | Structural | Planning | Survey paceengrs.com	**MACLEOD RECKORD** 231 SUMMIT AVENUE E. SEATTLE, WA 98102	DATE 7/7/06 SCALE 1"=10'	**BURKE-GILMAN TRAIL REDEVELOPMENT** FIGURE 6–TYPICAL INTERSECTION (PGIS)	JOB NUMBER **06601.00** DWG NO. P6601CALCS SHEET **FIG 6**

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V. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Conveyance Capacity

Conveyance capacity for the onsite improvements was sized for the 25-year peak storm event using KCRTS with 15-minute timesteps to calculate peak flows within each drainage sub-basin. See Appendix B for a complete description of how flows for each sub-basin were computed.

Conveyance capacity will be checked for each culvert crossing, existing and proposed, once the project moves into final design. At this time, typical sections are shown (See Figures 4 and 5) which depict the general conveyance scheme for the project. In general, existing cross culverts will be utilized for the trail improvements, and upgraded as necessary to convey the 25-year peak storm event.

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VI. SPECIAL REPORTS AND STUDIES

The following is a list of reports and studies related to this project.

- Preliminary Geotechnical Investigation by HWA Geosciences, Inc. dated April 15, 2005
- Burke-Gilman Trail Redevelopment: Drainage Analysis by PACE Engineers, Inc. dated April 17, 2005
- Burke-Gilman Trail: Wildlife Study by Adolfson dated April 6, 2005
- Burke-Gilman Trail Wetlands and Streams by Adolfson dated March 2005
- Arborists Report by Northwest Arborvitae dated March 31, 2005
- Draft Sensitive Areas Study by The Watershed Company dated March 30, 2006
- Draft Limited Phase I Environmental Site Assessment by Zipper Zeman Associates, Inc. dated April 5, 2006
- Phase One Final Report by Burke Gilman Trail Citizens Advisory Group dated February 17, 2006
- Burke Gilman Trail Standards review by Huitt-Zollars dated April 27, 2006

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VII. OTHER PERMITS

Other permits that may be required for this project include:

• Right-of-way Permit	King County
• Right-of-way Permit	City of Lake Forest Park
• Land Clearing, Grading, Excavating Permit	City of Lake Forest Park
• Sensitive Area Work Permit	City of Lake Forest Park
• Tree Removal Permit	City of Lake Forest Park

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VIII. ESC ANALYSIS AND DESIGN

All temporary erosion and sediment control requirements have been designed in accordance with Core Requirement #5 of the 2005 KCSWDM section 1.2.5 Erosion and Sediment Control. These standards prevent or reduce pollution of stormwater runoff caused by construction activities. The Temporary Erosion and Sediment Control Plan has been designed to minimize the amount of sediment laden runoff that leaves the project site, protecting downstream properties from construction and grading activities.

The site is 2.2 miles long and the improvements are a minimum of 12 feet wide. This equates to over three acres of land disturbing activities associated with the project. Therefore a Construction Stormwater Pollution Prevention Plan (CSWPPP) will need to be filed with the Washington State Department of Ecology. Temporary erosion and sediment control plans will also be prepared by PACE as part of the final design plans for the project.

The following is a narrative describing proposed TESC measures:

Clearing Limits: Clearing limits will be shown clearly on TESC plans with details sufficient to install and maintain during construction.

Cover Measures: The type and location of temporary cover measures to be used onsite will be shown on the TESC plans.

Perimeter Protection: Silt fencing location and details for installation will be shown on TESC plans.

Traffic Area Stabilization: Construction entrance locations shall be limited to as few as possible and shall be shown on the TESC plans. Dust control measures shall also be addressed on the plans.

Sediment Retention: Due to the long narrow nature of the project and limited area available, a sediment trap or pond will not be feasible for this project. Silt fencing and catch basin inserts shall be used primarily to trap sediments. Also stabilization of the site will help prevent sediments from migrating.

Surface Water Control: All surface water controls to be shown on final TESC plans per requirements of 2.3.1 of the ’05 KCSWDM.

Wet Season Requirements: A list of applicable wet season requirements shall be shown on the TESC plans. From October 1st through April 30th, no soils shall be exposed for more than two consecutive working days. Also, exposed soils shall

be stabilized at the end of the workday prior to a weekend, holiday, or predicted rain event.

Critical Areas Restrictions: The site has adjacent critical areas including streams, wetlands, and steep slopes. Critical areas shall be shown clearly on the TESC plans with protections as required.

IX. BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

Bond quantities shall be provided with the final engineering documents. No Facility Summary or Declaration of Covenant will be filed for this site.

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X. OPERATIONS AND MAINTENANCE MANUAL

The operations and maintenance manual has been compiled from Appendix A of the KCSWDM and is provided in Appendix A of this report.

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APPENDIX A: OPERATIONS AND MAINTENANCE MANUAL

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NO. 5 – CATCH BASINS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris (Includes Sediment)	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 basin by more than 10%.	No Trash or debris located immediately in front of catch basin opening.
		Trash or debris (in the 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.
		Trash or debris in any inlet or outlet pipe blocking more than $^1/_3$ of its height.	Inlet and outlet pipes free of trash or debris.
		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 the 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.
	Structure 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 (intent is to make sure all material is running into basin).	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 Basin Walls/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 structure is unsound.	Basin replaced or repaired to design standards.
		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	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Fire Hazard	Presence of chemicals such as natural gas, oil and gasoline.	No flammable chemicals present.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth present.
	Pollution	Nonflammable chemicals of more than ½ cubic foot per three feet of basin length.	No pollution present other than surface film.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by on maintenance person with proper tools. Bolts into frame have less than ½ inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying 80 lbs. of lift; intent is keep cover from sealing off access to maintenance.	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.

NO. 5 – CATCH BASINS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
Metal Grates (If Applicable)	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.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

NO. 6 – DEBRIS BARRIERS (E.G., TRASH RACKS)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed.
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier clear to receive capacity flow.
Metal	Damaged/Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than ¾ inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Repair or replace barrier to design standards.

NO. 7 – ENERGY DISSIPATERS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed.
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Replace rocks to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench must be redesigned or rebuilt to standards.
	Perforations Plugged.	Over ½ of perforations in pipe are plugged with debris and sediment.	Clean or replace perforated pipe.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility must be rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post. Baffles, Side of Chamber	Structure dissipating flow deteriorates to ½ or original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Replace structure to design standards.

NO. 10 – CONVEYANCE PIPES AND DITCHES

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & Debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
	Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
	Damaged	Protective coating is damaged; rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
		Any dent that decreases the cross section area of pipe by more than 20%.	Pipe repaired or replaced.
Open Ditches	Trash & Debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion Damage to Slopes	See "Detention Ponds" Table No. 1	See "Detention Ponds" Table No. 1
	Rock Lining Out of Place or Missing (If Applicable).	Maintenance person can see native soil beneath the rock lining.	Replace rocks to design standards.

NO. 11 – GROUNDS (LANDSCAPING)

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Weeds (Nonpoisonous, not noxious)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
	Safety Hazard	Any presence of poison ivy or other poisonous vegetation.	No poisonous vegetation present in landscaped area.
	Trash or Litter	Paper, cans, bottles, totaling more than 1 cubic foot within a landscaped area (trees and shrubs only) of 1,000 square feet.	Area clear of litter.
Trees and Shrubs	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	Tree or shrub in place free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; remove any dead or diseased trees.

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APPENDIX B: DRAINAGE ANALYSIS BY PACE DATED APRIL 17, 2005

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I PROJECT OVERVIEW

The Burke-Gilman Trail Redevelopment project consists of widening the existing Burke-Gilman Trail through the City of Lake Forest Park and providing where feasible a soft surface trail adjacent to the main trail. The overall length of the proposed improvements is approximately 2.2-miles.

This drainage analysis gives preliminary findings related to the capacity analysis of culverts crossing the Burke-Gilman trail, including a hydrologic analysis of the upstream drainage basins for each culvert in order to estimate the peak 25-year and 100-year flow rates at each culvert crossing.

II BACKGROUND

There are 14 drainage basins associated with 17 culvert crossings of the Burke-Gilman Trail. In addition, there are 2 bridge crossings that convey McAleer and Lyon Creeks under the trail, that are part of a larger basin area that have been studied extensively in the past by King County. As a result of these studies, several CIP projects have been constructed to reduce flooding. Further analysis based on a regional drainage basin study may be required to address predicted peak flows and conveyance capacity of the bridge crossings under the trail and is not part of this study.

Conveyance:
The Burke-Gilman Trail follows an abandoned railroad grade and is nearly flat for the two-mile stretch of the proposed redevelopment project. The trail is generally located at the toe of a steep slope, except within the McAleer and Lyon Creek basins where the surrounding topography is mainly flat upstream and gently sloping toward Lake Washington on the downstream side.

The existing conveyance system along the Burke-Gilman Trail is made up of a network of drainage ditches running parallel to the trail on the upstream side, interconnected with cross culverts which convey seepage and runoff across the trail to Lake Washington. Runoff and seepage that makes its way to these culvert crossings is generated upstream of the trail and is conveyed to the trail in a number of ways, including storm drainage piping, manmade ditches and natural drainage courses. Surface water runoff originates from rainfall and other precipitation falling within the drainage basin. Impervious surfaces such as roadways and roof contribute to the amount of runoff generated in each drainage basin. A discussion of how runoff from these surfaces is calculated is included in the methodology section of this analysis.

As part of the redevelopment and widening of the trail, the existing cross culverts will be analyzed to determine if they have adequate capacity to convey flows across the trail, and prevent flooding of the trail.

Flow Control:
Per the 2005 King County Surface Water Design Manual, this project is eligible for a direct discharge exemption from flow control. Criteria for this exemption is listed in section 1.2.3, page 1-30 of the manual. Lake Washington is a major receiving water body, and may receive direct discharge of surface water runoff. As such, no flow control facilities have been designed.

Water Quality Treatment:
Per the definition given on page 15 of the 2005 King County Surface Water Design Manual, the Burke-Gilman Trail is not a pollution generating impervious surface. Therefore, water quality treatment is not required for the improved area.

III METHODOLOGY

Existing Hydrology
The drainage analysis for this project was done per the KCRTS/Runoff Files Method described in Chapter 3 of the 2005 King County Surface Water Design Manual (KCSWDM). Runoff time series files were generated using 15-minute timesteps and a full historical record as required by table 3.2.2.A of the design manual. Impervious and pervious areas were calculated using GIS parcel data, and the guidelines in chapter 3 of the design manual. The following is a brief summary of the hydrologic analysis. Please note, as-built drawings of SR-522 were used to help determine drainage basin boundaries. The majority of runoff from SR-522 is conveyed in a piped system to McAleer and Lyon Creeks, upstream of crossing the Burke-Gilman Trail.

1. Culvert crossings of the trail were identified using the site survey and site visit for additional verification. In all, 17 culvert crossings and 2 bridges have been identified.
2. Upstream drainage basins for each culvert were mapped using topographic and drainage information provided by GIS mapping and as-built drawings of SR-522 provided by WSDOT. In all, 14 drainage basins draining to culvert crossings were identified. Some basins are drained by more than one culvert, and therefore there are fewer basins than culvert crossings. .
3. Using the GIS database, zoning within each mapped drainage basin was identified. The zoning was categorized into three groups: Single Family Residential (SF), Multi-Family/Commercial (MF/COM), and ROW.
4. The ROW area was divided and applied using a weighted average to either the SF grouping, or the MF/COM grouping.

5. For the SF areas within each sub-basin, the number of dwelling units per gross acre was calculated. Then, using Table 3.2.2.D of the KCSWDM, the percent impervious area was found. Next, the effective impervious fraction (EIF) from Table 3.2.2.E of the KCSWDM was used to give the total impervious area for the single family residential (SF) areas within each sub-basin. All pervious area was considered grass for this analysis.
6. For MF/COM areas within each drainage basin, a total impervious area of 90% was estimated based on an aerial photograph of the basins. Then, an EIF of 95% from Table 3.2.2.E was applied to the impervious areas. All pervious area was considered as grass for this analysis.
7. The impervious and pervious areas was totaled per sub-basin, and input into KCRTS using 15 minute timesteps and the full historical record.

Existing Conveyance Capacity of Culverts Crossing Trail:

A separate conveyance capacity analysis was completed for each culvert crossing of the Burke-Gilman Trail. Some assumptions were made where there was insufficient data from the survey. In particular, many of the outfalls were unable to be located due to their location on private property. All culverts where there was no survey information and we were unable to locate the inlet or outlet a minimum slope of 1% was applied. Manning's equation was used to calculate the full flow capacity of each culvert. Manning's equation was used to calculate flow based on cross-sectional area of pipe, pipe slope, and a roughness coefficient, which was assigned based on the type of pipe material. A smoother pipe (such as concrete or PVC) will have a greater capacity to convey stormwater than a corrugated pipe such as CMP.

IV FINDINGS

The capacity of each culvert was compared with the peak flows from the corresponding tributary drainage basin. The following table summarizes the results:

Culvert #	Culvert Capacity (cfs)	Drainage Basin #	Design Flow 25-year (cfs)	Design Flow 100-year (cfs)
1	16.0	1	20.8	37.3
1a	55.4	1a	1.7	2.5
2	25.1	2	7.2	12.8
3	22.6	3	7.8	13.0
4	22.6	4	2.9	4.7
5	22.6	5	3.4	5.5
6	66.7	6	4.0	6.0
7	33.2	7	2.8	4.2
8a	insufficient data	*8	175.7	311.2
8b	insufficient data			
8c	insufficient data			
9	36.1	9	11.6	17.8
10	36.1	10	16.2	24.3
11a	22.6	*11	6.5	10.8
11b	1.9			
12	10.5	12	6.0	10.0
13	3.6	13	1.2	2.1

*Basins 8 and 11 are drained by multiple culverts. A more detailed analysis is needed of basin 8 to determine culvert capacity.

Based on the results shown above, culvert number 1 may be undersized, and may need to be upgraded as part of the redevelopment of the trail. This will need to be analyzed in more detail during the final design. Also, the capacity of culverts draining basin 8 will need a more detailed evaluation during the final design phase since there is insufficient data based on the survey to determine the capacity of the existing culvert crossings for the drainage basin.

APPENDIX C: PRELIMINARY GEOTECHNICAL INVESTIGATION BY HWA GEOSCIENCES

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HWA GEOSCIENCES INC.

April 15, 2005
HWA Project No. 2005-027

Atelier Landscape Architects
120 Belmont Ave East
Seattle, Washington 98102-5603

Attention: Mr. Alex Shkerich

Subject: **PRELIMINARY GEOTECHNICAL INVESTIGATION**
Burke-Gilman Trail Redevelopment
NE 145th Street to Logboom Park
King County, Washington

Dear Alex,

This report presents our conclusions regarding potential geotechnical issues with redevelopment of the Burke-Gilman Trail along the subject section. We understand the County plans to redevelop the trail. Proposed improvements include widening the paved trail and providing a separate soft surface trail. The 2.3-mile long section of trail is located in Lake Forest Park and Kenmore, from the NE 145th Street alignment (boundary with City of Seattle) to Logboom Park in Kenmore.

Our understanding of the geotechnical issues for widening the trail in the subject section are based in part on our previous familiarity of the trail and surrounding areas, pre-design and design work conducted by HWA for other regional trails, a previous landslide study by HWA for the southern 500 feet or so of this section, and a limited reconnaissance of this section by HWA geologists on March 29, 2005.

EXISTING SITE CONDITIONS

The trail is parallel to, and a short distance from, the northwestern shore of Lake Washington, on a former railroad right of way. The trail gradient is generally flat, and at an elevation of around 35 feet. The trail at present consists of a 10-foot wide asphalt pavement, typically with a grass shoulder on one or both sides. In most areas the grass shoulder slopes away from the pavement, at various inclinations, from flat to 3H:1V (Horizontal:Vertical). In some cases the ground slopes steeply into a ditch, starting right at edge of pavement. In general, the width of the top of the old railroad bed is on the order of 11 to 16 feet, with considerable variation in short distances along the trail.

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Houses are present adjacent to the lake side of the trail along most of the section. On the upslope side, houses are farther from the trail, though near the top of the adjacent slopes. Streets and driveways both intersect, and are in close proximity, with the trail. The topographic configuration of the trail falls under the following scenarios when headed north on the trail:

1) **Uphill cut slope on left downhill fill slope on right:** This configuration is present along the majority of the section. The uphill slopes vary from a steep, high bluff at the south end (chronic landslide area in the southern 500 or so feet), to moderately steep slopes up to 50 feet high, to 10 to 15 foot high cuts with shallow slopes. The steep cut slopes appear to be within dense to very dense soils, with a thin covering (1/2 to 1 foot) of loose soil, derived from weathering and raveling of the slope (colluvium). At higher slopes with a shallow toe adjacent to the trail, the toe consists of an accumulation of colluvium and /or slide debris. A portion of the trail has a 10 to 15 foot high slope with the 10 to 15 foot high concrete retaining wall for Bothell Way at the top. A drainage ditch is present adjacent to the trail at the toe of the uphill slope. The downhill fill slope ranges from 2 to 10 feet high, and in most cases ranges between 4 and 8 feet. Where bordered by driveways or streets, the fill is retained by some type of wall, typically a concrete block wall or rockery. Where the slope is into a yard or natural area, it typically consists of a vegetated slope at an inclination from 1½ H:1V to 3H:1V.

2) **Downhill slope on both sides:** From the vicinity of NE 170th Street northeastward to just past Ballinger Way, the adjacent ground is at approximately the same grade as, to somewhat lower than, the trail. Deep, wet ditches are present on the left side in places, and McAleer and Lyon Creeks are crossed by the trail.

Geology

In general, the surficial geology in the study area consists of dense to very dense, glacially consolidated deposits forming the steep slopes, with loose to medium dense deposits derived from post-glacial erosion and landsliding forming colluvium in the low areas. The trail is atop the old track alignment, which is built on cuts into the dense soils and fills built over dense soils, as well as over loose colluvium, alluvium, and beach deposits.

Geologic information for the trail section was obtained from the *Preliminary Geologic Map of Seattle and Vicinity, Washington* (Waldron et al, 1962) and *Geologic Map of the Edmonds East and Part of the Edmonds West Quadrangles, Washington (Minard, 1983).*

Various geologic units are encountered along the project corridor. Very few geologic units have precise boundaries. The geology of an area can change drastically, both horizontally and vertically, within a few feet or, in some instances, can remain fairly consistent for hundreds of feet. In general, glacially consolidated, dense to very dense deposits are present within cuts and

natural slopes upslope from the trail, and colluvium, alluvium or beach deposits are present downslope from the trail.

Geologic Hazards

The southern portion of the trail section, from NE 145th to approximately NE 162nd Street, is within a Landslide Hazard Area as mapped in the King County Sensitive Areas Map Folio.

The northern portion of the trail section, from approximately NE 162nd Street to Logboom Park, is through a Seismic Hazard Area as mapped in the folio. Seismic hazard areas are generally defined as areas subject to severe risk of earthquake damage as a result of seismically induced settlement or soil liquefaction. Seismically induced liquefaction typically occurs in loose, saturated, sandy material commonly associated with recent stream, lake, and beach sedimentation, as well as with loose saturated fill.

GEOTECHNICAL DESIGN AND CONSTRUCTION CONSIDERATIONS

Redevelopment of the trail by constructing a wider paved trail and a separate soft surface trail may require widening of the existing trail bed / old railroad bed. This widening can be accomplished by placing fill on the downslope side, cutting into the upslope side, or a combination of the two. Downslope filling would, at most locations, require a retaining wall parallel to the trail due to right of way limitations. Upslope cutting would definitely require retaining walls since there is no place where the slope can be cut back to the top without impacting neighboring land. There are no significant geotechnical issues with widening in either direction. Both slope stability and drainage issues can be mitigated by proper design. However, cutting into the upslope side poses a potential liability risk. Once the toe of a steep slope is cut into, even when adequately retained, slides may still occur along the slope above and property owners might blame the cut and wall. Using the appropriate seismic design parameters in design can reduce the impact of seismic shaking on the redeveloped trail. Liquefaction susceptibility at critical structures should be identified by the geotechnical subsurface investigations during the design phase.

Downslope Widening

Widening the trail on the downslope side can be accomplished with fill, either retained by a wall or sloped to a stable inclination. Geotechnical issues with downslope widening include the potential for differential settlement of new fill where it adjoins existing grade, which may result in pavement cracking and settling. This possibility can be prevented with design of the fill, and proper fill placement and compaction methods during construction. Also, improper placement of fill over a slope can result in slope failure. This can be prevented with proper geotechnical design of the earthwork and retaining walls, and construction methods and performance that meet the design criteria.

Widening without the need for a retaining wall may be accomplished where there is sufficient width for placement of fill with a maximum sideslope inclination of 2H:1V. Fill placement would require removal of vegetation and organic soils, and benching the existing ground such that fill can be placed on level ground in horizontal lifts.

Upslope Widening

Widening by cutting into the existing uphill slope is complicated by two factors:

1) Maintaining adequate surface water and ground water drainage; and
2) The potential for destabilizing the slope downhill from existing homes or driveways.

Cuts into the slope may result in needing to export unsuitable soil and needing to import structural fill and/or drainage material.

Upslope widening would likely require moving or reconfiguring the existing ditch (see the "Drainage" section below). A drainage ditch would need to be maintained at the toe of the wall. Drainage measures behind the wall would be needed to capture ground water seepage.

Wall design will need to consider the potential for seasonally high runoff and ground water seepage volumes infiltrating into the wall backfill. For slopes significantly higher than the proposed wall, it is best to avoid cutting the wide footprint needed for an MSE or gravity wall. Soldier pile and lagging walls are preferable for such cuts, as the piles can be installed prior to cutting the slope, and the cut will only extend horizontally to between the piles, reducing potential impacts to the slope. For cuts that will be as high as the slope, or most of the height (e.g. steep slopes 10 feet high or less, with flat or gently sloping ground above), gravity walls could be considered. Concrete cantilevered walls may be suitable in this situation as well.

Potential Retaining Walls

There are numerous types of walls, each with its own advantages and disadvantages, depending on engineering considerations such as retained earth properties, foundation conditions, height, construction access and water. Outside influences such as property ownership, cost, and aesthetics are also factors.

Gravity Walls: There are many readily available alternatives for gravity walls. Some of the more common types include filled units such as gabion baskets; segmental concrete units such as Ultra-block, Lock-Block, or ecology blocks, and large rocks (rockeries). These walls are typically excavated in short segments (along the length of the wall) and the units are then placed with compacted backfill behind the wall. This type of wall is particularly well suited to areas with a minimum backslope and space for construction behind the wall. Stability of these walls depends on the inherent stability of the cut slope, e.g. slopes with stability issues should not be retained with gravity walls.

Mechanically Stabilized Earth (MSE) Walls: MSE walls include any wall that relies upon the interaction between a mechanical device (such as geogrid) and the soil to stabilize the soil and

allow it to stand near vertical. A common type of MSE wall is a geogrid reinforced segmented masonry unit (SMU) wall such as Mesa, Lock-Block, or Keystone. The wall site is prepared by clearing and grubbing the wall and fill footprint. If unsuitable soils are exposed at the wall footing, they are removed and replaced with structural fill. Generally the over-excavation is limited to immediately under the footprint of the wall. If the wall footing is in a low-lying area, localized dewatering, typically with sumps and pumps in the excavation, may be required.

One of the requirements for MSE walls is the need for adequate room behind the wall to lay out the reinforcing. For some of the potential wall locations, additional room may need to be created (i.e., soil removed) in order to install the reinforcing. Alternatively, anchors are sometimes used to hold the back of short reinforcing. Generally, the reinforcing is tied into the facing units and holds the facing up. The sequence for construction can involve placing the reinforcing, backfilling and compacting a lift of fill, placing another layer of reinforcing, tying it into the facing, backfilling on top of the second layer of reinforcing, and repeating.

MSE walls are particularly well suited for use as high walls where there is, or can easily be made, a wide bench on which to construct the wall. They will work under some circumstances where the foundation soils are marginal. Advantages of MSE walls include non-specialized construction, neat appearance, and ability to withstand differential settlement without failure. Disadvantages include the need for placing geogrid behind the blocks a distance equal to about 3/4ths the height of the wall. This would require excavating into the existing fill embankment or cut slope. For higher downslope walls, the excavation may extend into existing utilities within the trail bed. For less than about 3 feet in total height, it may be possible to eliminate the geogrid.

Concrete Cantilever Walls: Cantilever walls are constructed by building a concrete structure on a prepared surface and backfilling behind. They are particularly well suited for low walls where the foundation conditions are good. The necessary footprint behind the wall is typically narrower than for an MSE or gravity wall.

Soldier Pile and Lagging Walls: Soldier pile and lagging walls are constructed by installing vertical soldier piles and then placing lagging to hold back the soil between the piles. These walls derive their support from lateral pressure on the soldier piles below the front of the wall. They are particularly appropriate where there is limited area for structure behind the wall face. They can be constructed from either the top or bottom of the wall so the disturbance on the other side can be minimized. The soldier piles are usually either driven, auger-cast or cast in place piles placed on 4 to 8-foot spacing. Driven piles are usually H-piles. Driven piles can create construction vibrations and possibly settlement near the pile. Auger-cast and cast in place piles are drilled and cause less vibration. If necessary, the hole may be cased with the auger, a steel pipe, or filled with drilling fluid. Drilling fluid is usually a naturally occurring bentonite clay-based mud. Steel, usually an H-pile, is placed in the augured hole and structural concrete is tremied down, as the casing is lifted or the drill fluid is displaced. If drilling mud is used, there is a discharge of bentonite mud in a contained area on the ground surface that must be removed.

Sheet Pile Walls: Sheet pile walls may be used if the ground is soft. The sheet piles are usually driven with a vibratory hammer which creates significant vibration.

Drainage

Existing ditches may need to be partially filled in some areas. In many areas, slough and eroded soils that have partially filled the ditch will need to be removed to obtain the preferred ditch geometry. In either case, the adequacy of surface water drainage along the trail vicinity will depend on maintaining the ditches at the preferred depth range. Subgrade strength and therefore integrity of the trail pavement will also depend on keeping the trail bed in an unsaturated condition to a minimum of about 18 inches below pavement finish grade.

We recommend that ditch fill consist of compacted, structural fill. Prior to placement of the fill, existing vegetation, organic soils, and slough should be removed from the ditch. Structural fill for the new ditch bottom should then be placed and compacted in horizontal lifts. Fill placed for shallower sideslopes should be overbuilt, then trimmed to a 2H:1V inclination, and protected with long-term erosion control measures.

Existing Landslide Area

The existing slide area at the southern end of the section exhibits the worst case scenario. A cut into this slope should only be retained by a soldier pile wall, possibly with tiebacks, and would need some regrading of the slope above and structural fill placement behind the wall to improve stability of the slope (per our report dated 2/18/02). Cutting into this slope and constructing a retaining wall would not result in decreased slope stability; nor would the wall prevent future slides coming down from above.

Bridges

The existing bridges over McAleer and Lyon Creeks have decks that are 12 and 8 ½ feet wide, respectively. Either the bridge structures would need to be rebuilt wider over the existing foundations, or the bridges would need to be completely rebuilt. If new foundations are necessary, the bridge foundations may be either driven, auger-cast, or cast in place piles. The driven piles could be H-piles, pipe piles, timber piles, or pre-cast concrete piles. Selection of pile type, size, and spacing would depend upon the soil properties, potential for obstructions, design loads, and availability of construction equipment and materials. Impacts from driving piles would be vibrations and noise. Driving piles requires large construction equipment and a laydown area nearby. The biggest impact of constructing auger cast or cast in place piles is the removal and disposal of native materials and perhaps drilling mud.

Pavements

Settled pavements were observed in a few areas, within the outer couple of feet of the downslope side of the trail, in a linear fashion – e.g, settlement appears to have occurred along utility trench backfill. The potential for differential settlement between new fill and existing trail grade can be

reduced by removing all of the old pavement, and proof-rolling to identify any soft areas (which can be improved by over-excavation and replacement with structural fill).

Access to, and along, the existing trail with dump trucks and heavy equipment will need to be considered. Pavements on the existing trail, as well as streets and driveways used for access, are likely to experience distress from construction traffic.

LIMITATIONS

We have prepared this preliminary report for Atelier Landscape Architects and King County Parks for use in pre-design of a portion of this project. Experience has shown that soil and ground water conditions can vary significantly over small distances and there was no subsurface exploration done for this study. Therefore variations from the information presented herein should be expected.

Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology in the area at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or ground water at this site.

We appreciate this opportunity to be of service.

HWA GEOSCIENCES INC.

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BWT:TCK:bwt