CITY OF KENMORE

KING COUNTY **WASHINGTON**

TRIBUTARY 057 SEDIMENT STUDY

G&O #09517
JUNE 2010

Gray & Osborne, Inc.
CONSULTING ENGINEERS

CITY OF KENMORE

KING COUNTY WASHINGTON

TRIBUTARY 057 SEDIMENT STUDY

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JUNE 2010

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EXECUTIVE SUMMARY

The Tributary 057 Sediment Study for the City of Kenmore provides City staff and policymakers sufficient information on the sources, quantity, and management options for sediment control to improve the level of service to the residents of the City and maintain the street and surface water system effectively. This study provides a basin-wide analysis which will look at sources, historical load volumes, modeling flows and hydraulics to estimate yield, maintenance activities to manage, and alternatives for regulatory and physical control.

Sediment erosion and subsequent transport to the lower reaches of the stream system is a natural process that has been occurring throughout all geologic time periods. Human activity and development can exacerbate the natural process, but short of complete hardening of the entire drainage basin, the erosion will continue to occur.

The City has identified a number of chronic sediment maintenance problems in the surface water conveyance system of the basin of Tributary 057, which is generally bounded by 72nd Avenue NE to the west, NE 148th Street to the south, 83rd Avenue NE to the east and the Sammamish River to the north. The basin is approximately 160 acres in area.

The majority of Tributary 057 was physically inventoried to assess the condition of the stream, locate and estimate sediment sources and volumes, and evaluate the mobility of the sediment. This information is presented in a sediment study completed by GeoEngineers included in Appendix C of the report. To assess the capacity of the storm drainage system, a numeric computer model was developed using existing Geographic Information System data, as-built maps of developments, local survey for specific areas such as the Wildcliffe Shores' wetland/floodplain, culvert crossings within the public rights-of-way, and areas of known stream channel instability.

The upper reaches of the basin provide the primary source of sediment and the geology and topography of the basin will continue to provide sediment for decades to come. Due to the nature of the surface water runoff, management of the sediment is needed to minimize the damage to property and maintain adequate infrastructure.

The hydrologic and hydraulic modeling also show the existing 24-inch culvert at 74th Avenue NE does not have sufficient capacity to convey the 25- or 100-year storm event. While not specifically within the scope of this study, replacement of this culvert is recommended.

The ten areas where structural sediment control facilities could be constructed are described descending from the upper reaches of the basin to the Sammamish River.

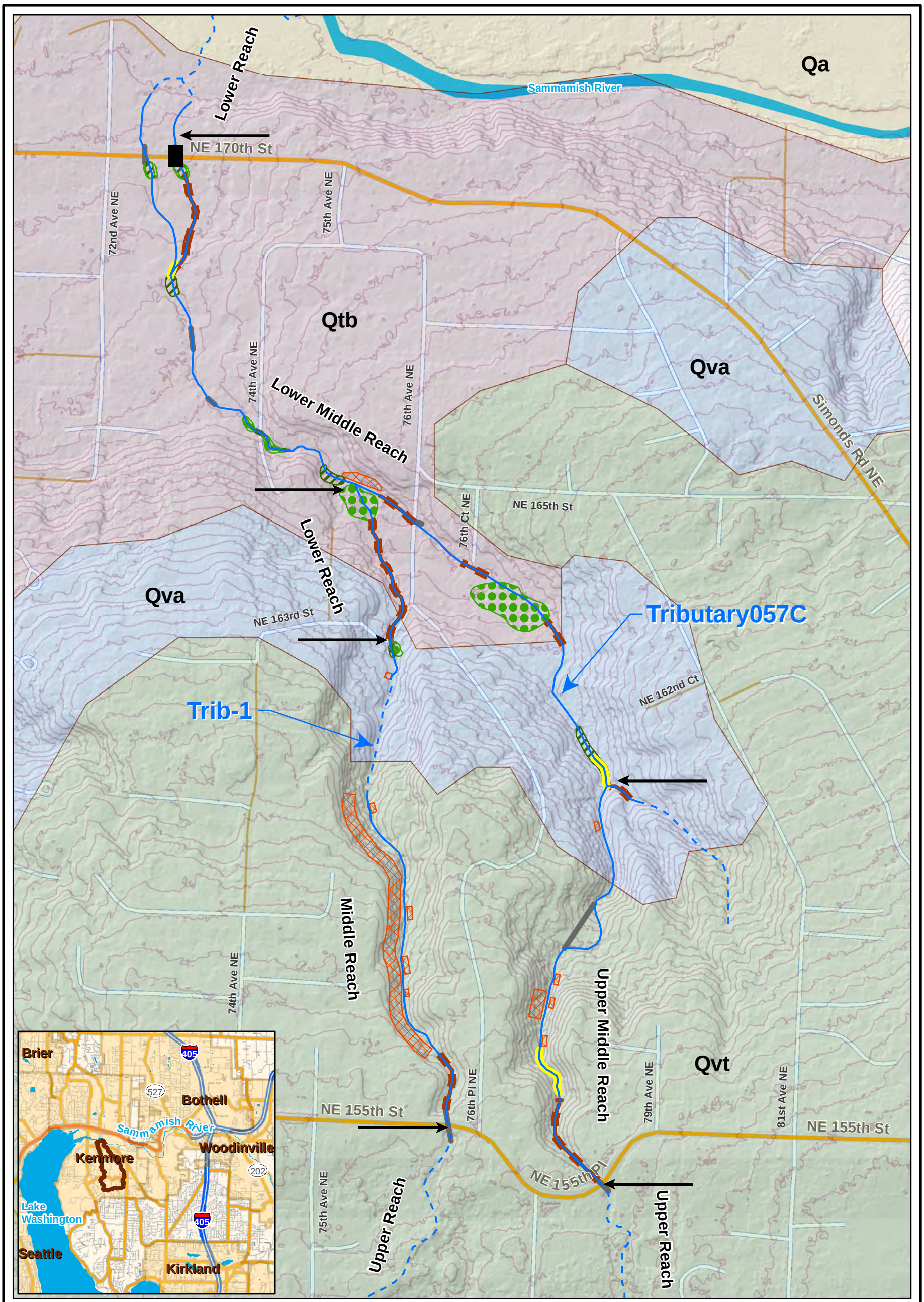
TABLE ES-1

Cost Estimates/Project Ranking

Area	Description	Cost Estimate	Capital Cost	Sediment Management Benefit	Design Effort	Permit Complexity	Environmental Benefit	Maintenance Cost	Total Evaluation Score
1	Detention Facility at 155th	$621,000	1	1	4	4	2	5	**17**
2	Sediment Trap at Private Drive	$276,000	3	1	3	4	3	2	**16**
3	Sediment Trap near 76th	$ 90,000	5	2	3	3	2	2	**17**
4	Sediment Trap at 76th	$299,000	3	2	3	3	3	2	**16**
5	Sediment Vault at 163rd	$520,000	2	4	3	3	3	3	**18**
6	Sediment Trap at 163rd	$162,000	3	3	3	3	3	2	**17**
7	Sediment Trap at 74th	$477,000	2	3	3	3	4	2	**17**
8	Enlarge Existing Sediment Trap	$797,000	1	4	3	3	3	4	**18**
9	Box Culvert at 170th	$649,000	1	5	2	2	4	5	**19**
10	Ecology Blocks at 170th	$558,000	1	5	2	2	5	5	**20**

The recommended Capital Project is Area 10 of the list above, and includes removal of the existing sediment trap in NE 170th Street and installation of an open channel with concrete block walls within an easement and an open sediment collection area at the discharge. This alternative provides the greatest flood reduction, ecological benefit, and least long-term maintenance effort.

Control and energy dissipation of public and private surface water collection and conveyance systems should be implemented wherever possible. The two culvert discharges under NE 155th Street should have some improvements provided to halt the existing scouring. All private downspout and drainage outfalls within the ravines between NE 155th Street and NE 165th Street should be tightlined down as close as possible to the stream and have dispersion methods to limit local erosion.



Base Information

- Channel Surveyed
- Channel Not Surveyed
- Reach Breaks
- 10 ft Contours
- Sediment Trap
- Culverts

Processes

- Lateral Incision
- Vertical Incision
- Deposition in Channel
- Deposition in Overbank
- Mass Wasting

Geology

- Qa - alluvium
- Qvt - continental glacial till
- Qva - advance outwash
- Qtb - transitional beds

N W E S

0 200 400 800 Feet

Figure ES-1 Active Processes

City of Kenmore Basin Sediment Study
Kenmore, WA

GeoEngineers

Gray & Osborne, Inc. Consulting Engineers

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

Reference: Field sketch data from GeoEngineers. Base data from ESRI and King County. Slopes and contours derived from LiDAR provided by King County. Data projected as NAD 83 HARN Stateplane Washington North (feet).

CHAPTER 1

INTRODUCTION

The City of Kenmore (City) has identified a number of chronic sediment maintenance problems in the surface water conveyance system of the City. A number of these problems are in the drainage basins south of and draining to the Sammamish River. One of these basins is Tributary 057, which is generally bounded by 72nd Avenue NE to the west, NE 148th Street to the south, 83rd Avenue NE to the east, and the Sammamish River to the north.

The City has specifically identified the problem areas as Tributary 057 and the sediment vault at NE 170th Street and 72nd Avenue NE. Sediment is removed annually under a programmatic Hydraulic Project Approval (HPA) at the sediment trap (vault). The vault, completed by King County in 1998 prior to the City's incorporation, has a capacity of about 50 cubic yards. This vault lacks the capacity to effectively manage the sediment load it receives. In some years, the vault requires multiple cleanings. The vault and associated cross culverts have overtopped during large storm events, causing roads to be temporarily closed and causing flooding and sedimentation into neighboring streets, driveways, and yards. This history of sediment management issues prompted the City to investigate the sources, quantity, and management options for sediment control to maintain street and surface water systems effectively.

Two culverts (stream crossings) are located at NE 163rd Street near 76th Avenue NE and at 74th Avenue NE near NE 165th Street. These culverts have overtopped during heavy storm events, have eroded around the outfall and caused road shoulder failure, or have had excessive sediment buildup at their inverts or outlets. Sediment is removed under an annual programmatic HPA from the Washington State Department of Fish & Wildlife (WSDFW).

This study will be a basin-wide effort, generally upstream of the Sammamish River and the sediment control structure at NE 170th Street. Gray & Osborne has researched sources, historical load volumes, and maintenance activities to manage sediment; has modeled flows and hydraulics to estimate sediment yield; and has developed alternatives for controlling sediment both from a programmatic (regulatory) framework as well as a site-specific (physical/structural) approach. The goal of this study is to allow the City to immediately initiate design documents for construction in 2010 of the selected management alternative.

STUDY ORGANIZATION

The report is organized as follows:

- Executive Summary
- Chapter 1 – Introduction: Provide an overview of the project, contract, and scope.
- Chapter 2 – Existing System: Describes the study basin, existing surface water conditions, and conveyance system.
- Chapter 3 – Hydrologic and Hydraulic Analysis: Summarizes the computer modeling used to estimate flows and system capacity.
- Chapter 4 – Sediment Analysis and Control: Provides a summary of the findings of the field investigation and analysis.
- Chapter 5 – Capital Improvements: Describes the alternatives and recommendation for addressing sediment management and flooding issues.

SCOPE OF WORK

The City contracted with Gray & Osborne in May 2009 to prepare a sediment study of the basin. The following scope details the contractual requirements. Development of the Tributary 057 Sediment Study included the following described below.

TASK I: LITERATURE REVIEW

Research, compile, and review available literature, maps, and background materials, as well as available digital geospatial information within Tributary 057. Once review has been done, assist the City with development of a GIS database to develop maps of likely sediment source and depositional areas. Also review available hydrologic and hydraulic information pertinent to sediment source mobilization, transport, and fate evaluations.

Deliverables: Results of the literature review will be included with deliverables identified for Task II.

TASK II: FIELD RECONNAISSANCE

Gray & Osborne and its subconsultants (fluvial geomorphologist) meet on site with the City staff to perform site reconnaissance for the project. The reconnaissance surveys will provide an opportunity to observe existing channel features and processes, effects of recent flood flows on existing channels, bank features, surface water infrastructure and facilities, and to explore potential sediment sources, transport zones, and depositional areas. Discussions with the City will include geomorphic functionality of existing features and potential treatments to reduce the likelihood of future surface water and flooding events.

Deliverables: A qualitative characterization of basin and reach-scale conditions will be completed prior to site surveys to be completed in Task IV. Preliminary mapping of drainage features will be produced and will be used to guide field efforts in Task IV.

TASK III: HYDROLOGIC AND HYDRAULIC MODELING

Review existing hydrologic information and perform hydrologic and hydraulic modeling needed to assess potential management alternatives. The hydrologic and hydraulic work will include review of any existing hydrologic reports for the area, and develop a hydrological simulation program model for existing and future flow conditions that will be used for hydraulic modeling. Peak flows for existing and future conditions for the 2-, 10-, 25-, and 100-year storms will be developed. The subbasin was delineated as part of the Surface Water Management Program in 2008 (OTAK). The work will use basin information from the existing report as a basis to develop a model.

Gray & Osborne will develop a hydraulic model for the existing and proposed alternatives using XP-SWMM. The model will provide the flow and backwater results for the existing drainage system for the 2-, 10-, 25-, and 100-year storm events for existing basin conditions, and for the proposed drainage system for the 2-, 10-, 25-, and 100-year storm events for existing and future basin conditions.

A draft of the Hydrologic and Hydraulic Analysis Report for the project describing the modeling performed and the results will be submitted during the first half of the project design. The draft report will be used to evaluate the existing conditions, and help evaluate and select the sediment management alternatives. A Final Hydrologic and Hydraulic Report for the project will be submitted during the second half of the basin study. The final report will contain the analysis, methodology, figures, graphs, tables, and computer program results (located in the Appendix). Gray & Osborne will provide a draft report for City review and comment before finalizing the report.

Deliverables: Draft and final Hydrologic and Hydraulic Analysis Reports.

TASK IV: SEDIMENT SOURCE, TRANSPORT, FATE SURVEYS

Field Surveys

Gray & Osborne and its subconsultants' staff will conduct field surveys at each stream within the Tributary 057 subbasin. Surveys will focus on identifying and mapping sediment source areas upstream of problem culverts, identifying the processes of recruitment, transport, and deposition, as well as identifying local conditions controlling and/or accelerating local bank/streambed erosion, deposition, and channel/culvert interaction upstream and downstream of the culverts.

During site surveys, Gray & Osborne and its subconsultants will document channel dimensions, thalweg gradient, bank soil, and streambed composition. Sediment sampling will be completed using bulk collection and point count methods for bank soils and streambed composition, respectively.

Sediment Mapping and Modeling

Using information collected in the field together with reports and data collected in Task I, Gray & Osborne and its subconsultants will complete sediment transport and scour analyses as necessary at each site. Observations made in Task IV will be used to refine geomorphic characterization of each stream identified in Tasks I and II.

Deliverables: Results of analyses will be incorporated into report, maps, and presentation materials (see Task III). Any conceptual designs, infrastructure modifications, or treatment alternatives will be developed as part of Task VI and provided in the final report (see Task VIII).

TASK V: SEDIMENT CONTROL ALTERNATIVES

Utilizing data from the model and discussions with City staff, Gray & Osborne will identify deficiencies in the surface water conveyance system and develop alternatives for managing sediment. These alternatives will likely include programmatic steps (enhanced erosion control for construction projects, review of road maintenance activities, increased level of surface water management, etc.), and capital improvement projects necessary to provide adequate capacity for the existing conditions and development within the existing and future basin. Each alternative will include a detailed planning level cost estimate. Gray & Osborne will identify system improvements which, if implemented, would result in operations and maintenance savings, and identify preferred alternatives and prioritize projects based on existing system needs and facilities needed to serve the existing and future basin needs.

This scope of work assumes three capital projects will be investigated to the level of a predesign report.

Gray & Osborne will attend and participate in one public workshop and City Council meeting if requested.

TASK VI: SURVEY FOR POTENTIAL CAPITAL PROJECT LOCATIONS

If desired by the City, site survey will be performed to establish horizontal and vertical control, reference existing monumentation and property corners, and verify the location and size of existing infrastructure and topography (as necessary) for up to three capital project locations. Gray & Osborne will acquire relevant recorded documentation of record surveys and utility maps, as necessary. Absent specific written direction to the contrary providing for verification, the Engineer shall be entitled to rely upon the

completion and accuracy of such documentation. Survey control points will be physically set for site reference control, as necessary. Cross sections and profiles(s) will be provided as may be required. Physical features including structures, streets, fences, trees, utility poles, signs, edges of pavement, ditches, fire hydrants, etc., will be noted for plotting. Property owners will be notified and permission requested prior to surveying on private property. It is anticipated that the need for each site survey will be limited to 8 hours.

Temporary construction and permanent drainage easements requirements shall be completed as required for the proposed project(s).

TASK VII: REGULATORY REQUIREMENTS REVIEW

Gray & Osborne will assist the City by identifying likely permit applications and agreements required for proposed project construction including local permits (clearing and grading, critical areas ordinance compliance, and right-of-way as needed), HPA with WSDFW, potential wetland impacts, and easement(s) with adjacent property owners.

TASK VIII: SEDIMENT STUDY REPORT

Gray & Osborne will prepare draft and final reports summarizing the results and findings of the sediment analyses. The report will include a figure identifying the location of sediment sources, transport areas, and sediment depositional areas. Gray & Osborne and its subconsultants' staff will also develop presentation materials to be shared with the City. Gray & Osborne and its subconsultants' staff will attend a meeting with the City to discuss our results and develop possible design alternatives. Draft and final reports will outline our project approach, results, and discuss findings. A recommendations section will be included in the report.

Deliverables: Draft Report, Final Report, and Public Presentation.

TASK IX – QUALITY ASSURANCE/QUALITY CONTROL

Gray & Osborne and its subconsultants will conduct in-house quality assurance/quality control reviews at the 5, 35, and 90 percent levels of design. City staff is welcomed and encouraged to attend the QA/QC sessions.

CHAPTER 2

EXISTING CONDITIONS

This chapter presents existing conditions of the project area and a description of the existing stormwater system within Tributary 057. The surface water drainage conveyance system consists of components such as streams, open ditches, catch basins, and pipes.

The Tributary 057 system is composed mainly of streams and ditches with catch basin and culverts when crossing under roads.

LOCATION

The City is located in western King County. The City includes approximately 6.3 square miles (4,032 acres) along the north end of Lake Washington. Development covers a majority of the City. The City shoreline areas include ±3.2 miles of Lake Washington shoreline, ±3.8 miles of Sammamish River shoreline, and ±4.5 miles of shoreline associated with Swamp Creek. The City boundary with relation to Lake Washington depicted on Figure 2-1.

CLIMATE

Kenmore experiences relatively mild temperatures with damp, cool winters, and mild, dry summers. The air temperature is influenced by the surrounding water temperatures and remains fairly constant year-round. The prevailing wind direction is from the southeast in the winter and southwest in the summer. A wet season usually begins in October and lasts until May. At that time the dry season begins, peaking around July.

Data regarding the 2-, 10-, and 100-year storms with 24-hour durations were obtained from isopluvial maps in Ecology's *Stormwater Management Manual for the Puget Sound Basin*.

Kenmore Design Storms	24-hour Precipitation
2-year	1.6 inches
10-year	2.6 inches
100-year	3.6 inches

CRITICAL AND SENSITIVE AREAS

The Tributary 057 basin includes geologically hazardous areas based on their susceptibility to erosion, sliding, earthquakes, or other geological events that are not suited to site commercial, residential, or industrial development.

Only the discharge of Tributary 057 to the Sammamish River is within the FEMA 100-year floodplain. The 100-year floodplains are situated along portions of the Sammamish River and a tributary to the north of the river. The FEMA 100-year floodplain does not cover all areas subject to localized flooding.

Wetlands are present adjacent to the stream channel near the outfall of Tributary 057 to the Sammamish River. Wetlands are defined as those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

PHYSICAL DESCRIPTION

The topography of the City of Kenmore generally slopes towards Lake Washington or its tributary streams (Sammamish River). The downtown area, in the central section of the City, is relatively flat as are areas along the shoreline.

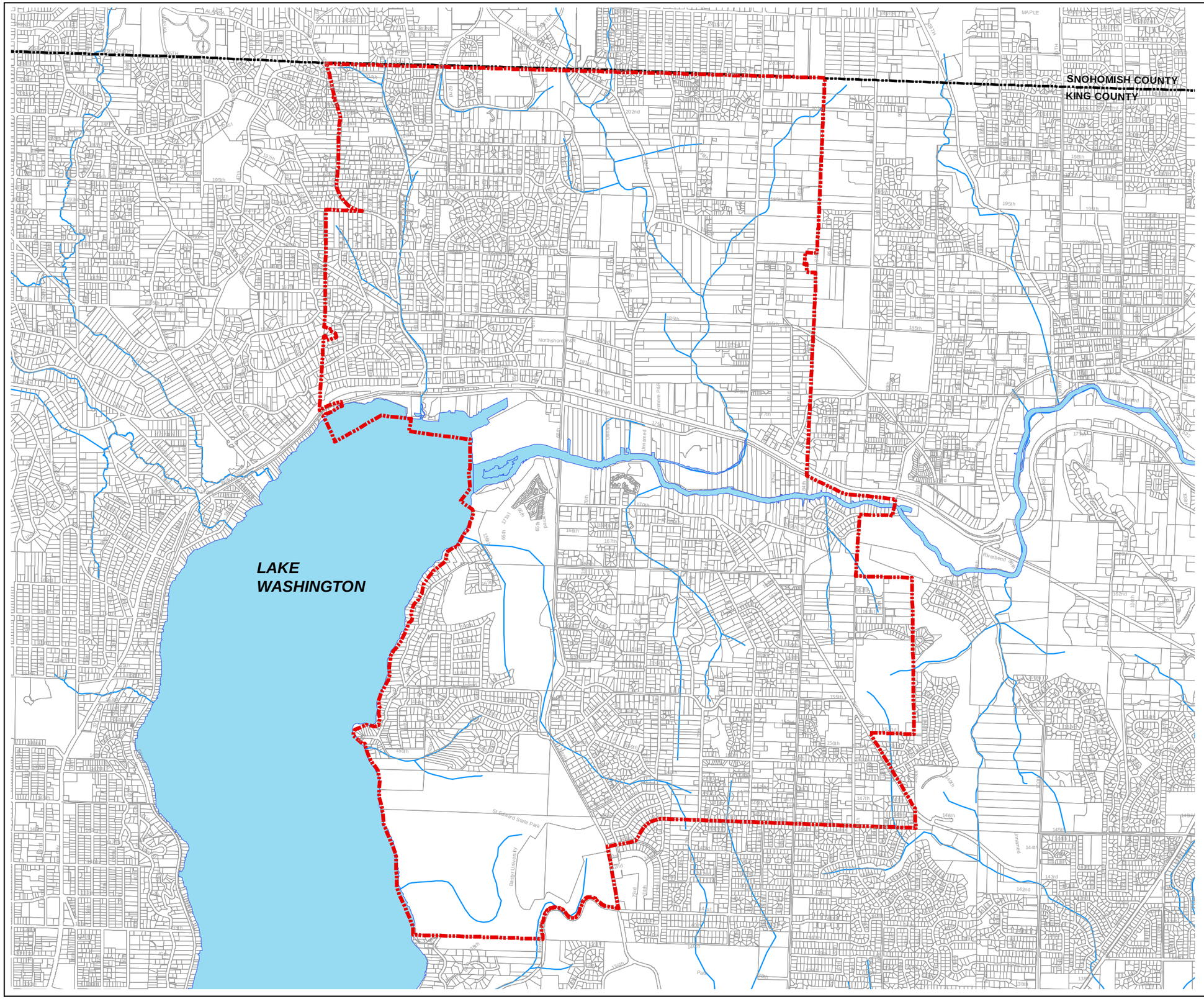
The sensitive areas within the project area include erosion hazard areas, flood hazard areas, and wetlands (Figure 2-2).

SOILS

The hydrologic soil groups in Kenmore are shown on Figure 2-3. The major soil units for most of the soils are Alderwood and Kitsap soils. Alderwood soils are characterized by gravelly sandy loam (0% to 30% slopes) that are moderately well drained. Kitsap soils are characterized by silt loam (2% to 30% slopes) and are also moderately well drained.

The soils characteristics for the Kenmore area were obtained from the Soil Survey of King County Area, Washington, provided by the United States Department of Agriculture Natural Resource Conservation Service (formerly known as the Soil Conservation Service).

The soils are classified as defined in the 2009 King County Surface Water Design Manual, as adopted by the City. Soil Type A has the lowest runoff and highest infiltration capacity. Soil Type D has the highest runoff potential and poorest infiltration. Table 2-1 summarizes the soils within Tributary 057.



N

0 2,000 4,000 Feet

LEGEND:

- CITY LIMITS
- COUNTY LINE
- LAKES
- PARCELS
- RIVERS / CREEKS / STREAMS

CITY OF KENMORE

BASIN SEDIMENT STUDY
FIGURE 2-1
CITY BOUNDARY

Gray & Osborne, Inc.
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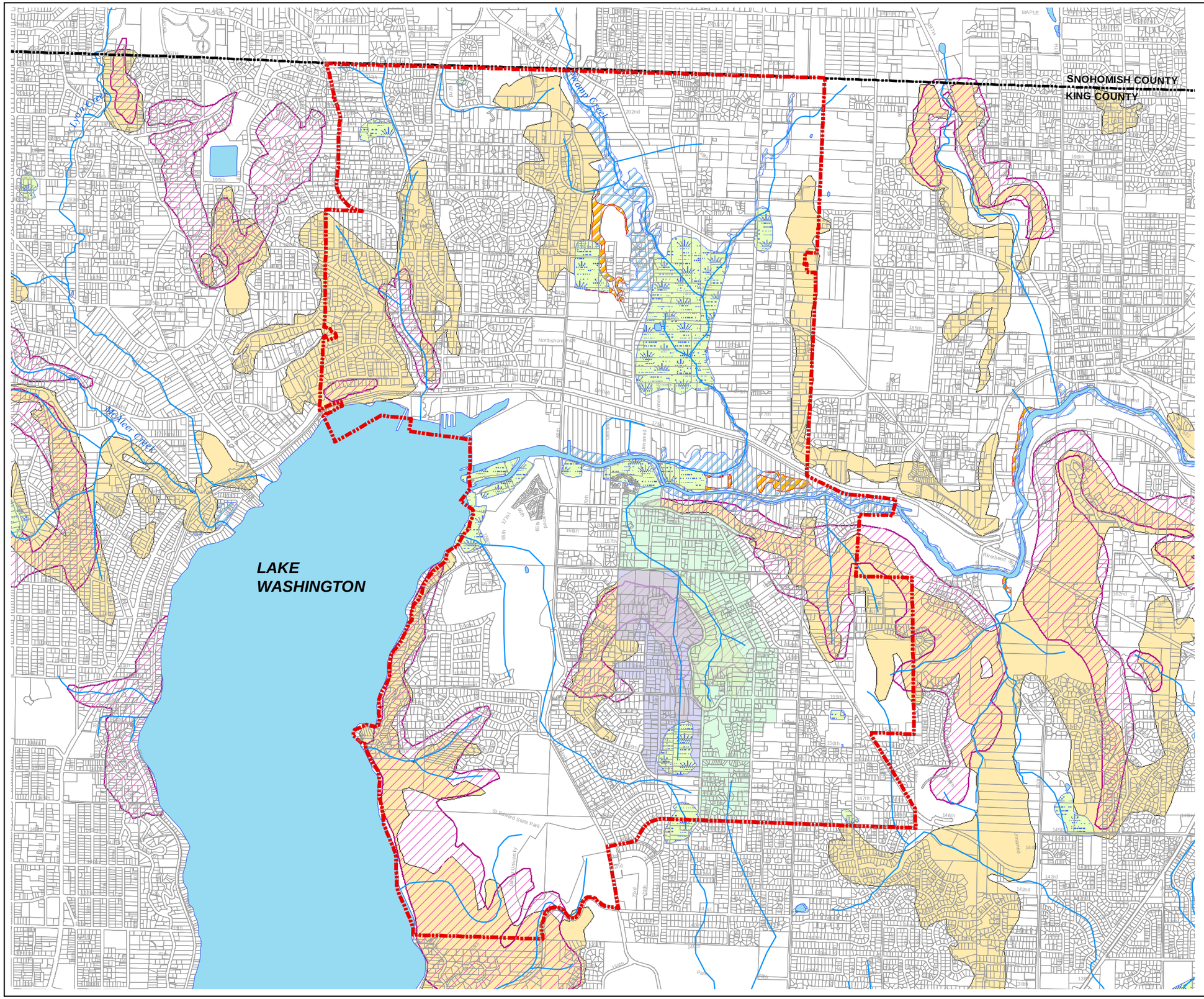

N

0 2,000 4,000 Feet

LEGEND:

- CITY LIMITS
- COUNTY LINE
- STREAMS
- WATER
- PARCELS
- WETLANDS
- TRIBUTARY BASIN 057
- TRIBUTARY BASIN 058
- LANDSLIDE HAZARD
- EROSION HAZARD

FLOODPLAIN ZONE

- 100 YEAR
- 500 YEAR

CITY OF KENMORE

BASIN SEDIMENT STUDY
FIGURE 2-2
CRITICAL AREAS

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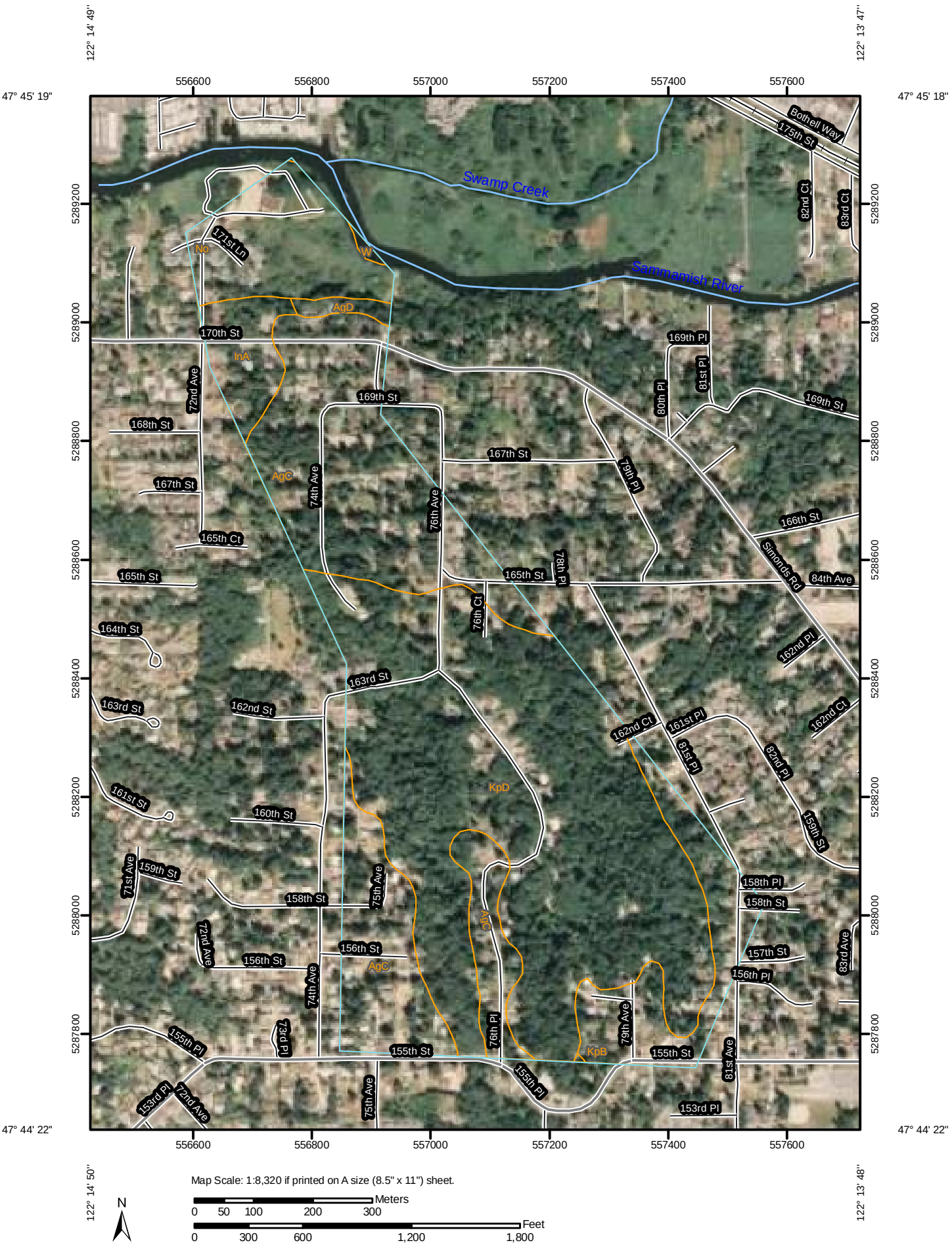


Map Scale: 1:8,320 if printed on A size (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 300 600 1,200 1,800

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:8,320 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 6, Sep 22, 2009

Date(s) aerial images were photographed: 7/24/2006

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

King County Area, Washington (WA633)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AgC	Alderwood gravelly sandy loam, 6 to 15 percent slopes	48.5	30.5%
AgD	Alderwood gravelly sandy loam, 15 to 30 percent slopes	1.2	0.7%
InA	Indianola loamy fine sand, 0 to 4 percent slopes	5.8	3.7%
KpB	Kitsap silt loam, 2 to 8 percent slopes	12.5	7.9%
KpD	Kitsap silt loam, 15 to 30 percent slopes	77.3	48.7%
No	Norma sandy loam	13.2	8.3%
W	Water	0.3	0.2%
Totals for Area of Interest		**158.7**	**100.0%**

TABLE 2-1

Tributary 057 Soils

Soil Group	Area (acres)	% Area
A	6	4%
B	0	0%
C	148	96%
D	0	0%
Total	**154**	**100%**

LAND USE AND ZONING

Land use within the City has generally developed in a suburban and urban manner. Throughout this area, drainage has been accomplished along the streets through a number of open ditches, culverts, various-sized pipes and catch basins, detention ponds, and vaults. Existing zoning within the study basin is almost entirely residential and is shown on the City's Zoning Map (see Figure 2-4).

BASIN DESCRIPTION

This project is located within the Sammamish River Drainage Basin in the City. The entire Sammamish River drainage basin is approximately 153,600 acres, while Tributary 057 and its main tributary cover approximately 160 acres. The project area is bordered to the north by the Sammamish River, to the south by NE 155th Street, to the east by 72nd Avenue NE and to the west of 81st Place NE. All areas within the Tributary 057 area lie within the City and are zoned as residential. The tributaries run through private properties and cross through rights-of-way.

A condominium development is located in alluvial deposits where the tributary joins the Sammamish River. Historically, this area was shoreline or inundated by Lake Washington prior to the construction of the Hiram M. Chittenden Locks. Following this construction, Lake Washington was lowered by approximately 10 feet.

Throughout this area, drainage has been accomplished along the streets through a number of open ditches, culverts, various-sized pipes and catch basins, detention ponds, and vaults. Tributary 057 is primarily a natural stream channel except for culverts at road crossings and private access. Based on the field reconnaissance, there are eight known culverts, including the sediment vault and overflow culvert at NE 170th Street.

The existing sediment vault retains approximately 50 cubic yards. In previous years, the vault was typically cleaned only once in the fall. In 2009, because of concerns regarding the quantity of sediment in the stream, the vault was cleaned a second time. The second

cleaning occurred outside the permitted cleaning period (outside the fish window) and required de-fishing prior to cleaning. The cost of cleaning the vault is $3,000 per event and de-fishing costs $3,000.

DRAINAGE COMPLAINTS

In King County, the drainage complaints are kept on file for 10 years. Thus, the applicable drainage complaints for this project from 1999 to present were able to be researched.

These drainage complaints included the following categories:

1. Flooding (2)
2. Pollution (2)
3. Property Maintenance (1)
4. Landslide Potential (1)
5. Sediment Accumulation (1)
6. Checking on Stormwater System Functionality (1)

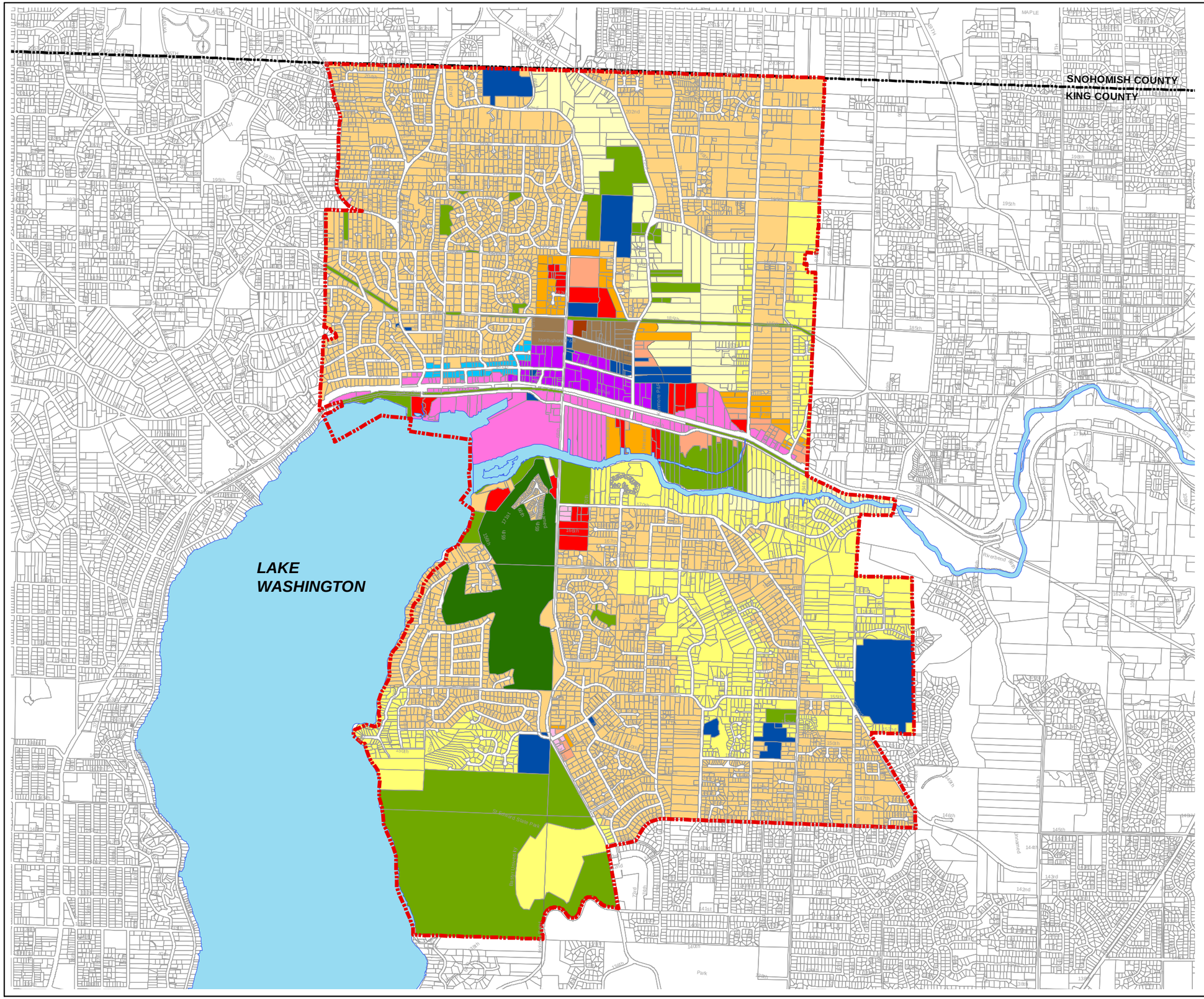
Wildcliffe Shores Condominiums (the northernmost properties of Tributary 057) filed drainage complaints regarding flooding and pollution. All appear to have been resolved at the time the drainage complaint was addressed.

Copies of the complaints are located in Appendix A. A map has also been included to better understand the complaint locations with respect to the project area.

EXISTING DRAINAGE SURVEY

The evaluation of this study consists of an inventory of the existing public stormwater drainage system. This was compiled from field inspection data as well as information and existing as-built maps provided by City and King County. This information has been compiled into a Geographic Information System (GIS) database as shown on Figure 2-5 (by GeoEngineers). The GIS database provides a tool for developing a program to track locations of problematic areas.

The field inspection consisted of an initial reconnaissance survey followed by Gray & Osborne and GeoEngineers staff walking the majority of the stream channel upstream from the Sammamish River along Tributary 057 and its main tributary (Trib-1). The bulk of the system is a meandering stream with a few culverts and catch basins to cross under roads and driveways. The drainage survey was completed to determine locations where sediment could originate and be carried downstream to cause drainage problems. The field report is provided in Appendix B.



CITY OF KENMORE

BASIN SEDIMENT STUDY
FIGURE 2-4
ZONING PLAN

Gray & Osborne, Inc.
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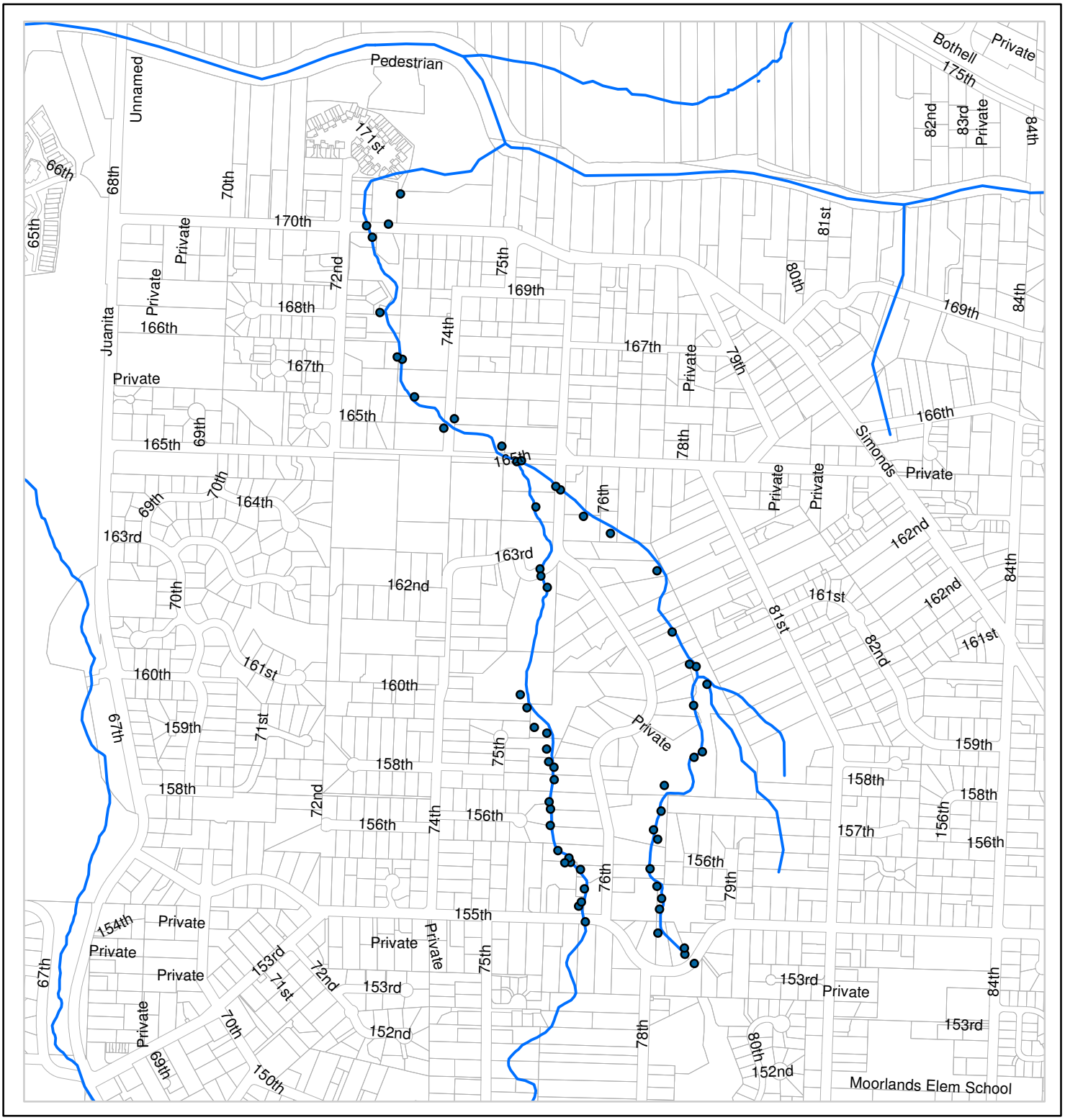

LEGEND

- GPS Locations
- Streams
- Roads
- Parcels

N

800 400 0 800 Feet

CITY OF KENMORE

TRIBUTARY 057 SEDIMENT STUDY

FIGURE 2-5

TRIBUTARY 057 BASIN FIELD RECONNAISSANCE GPS LOCATIONS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

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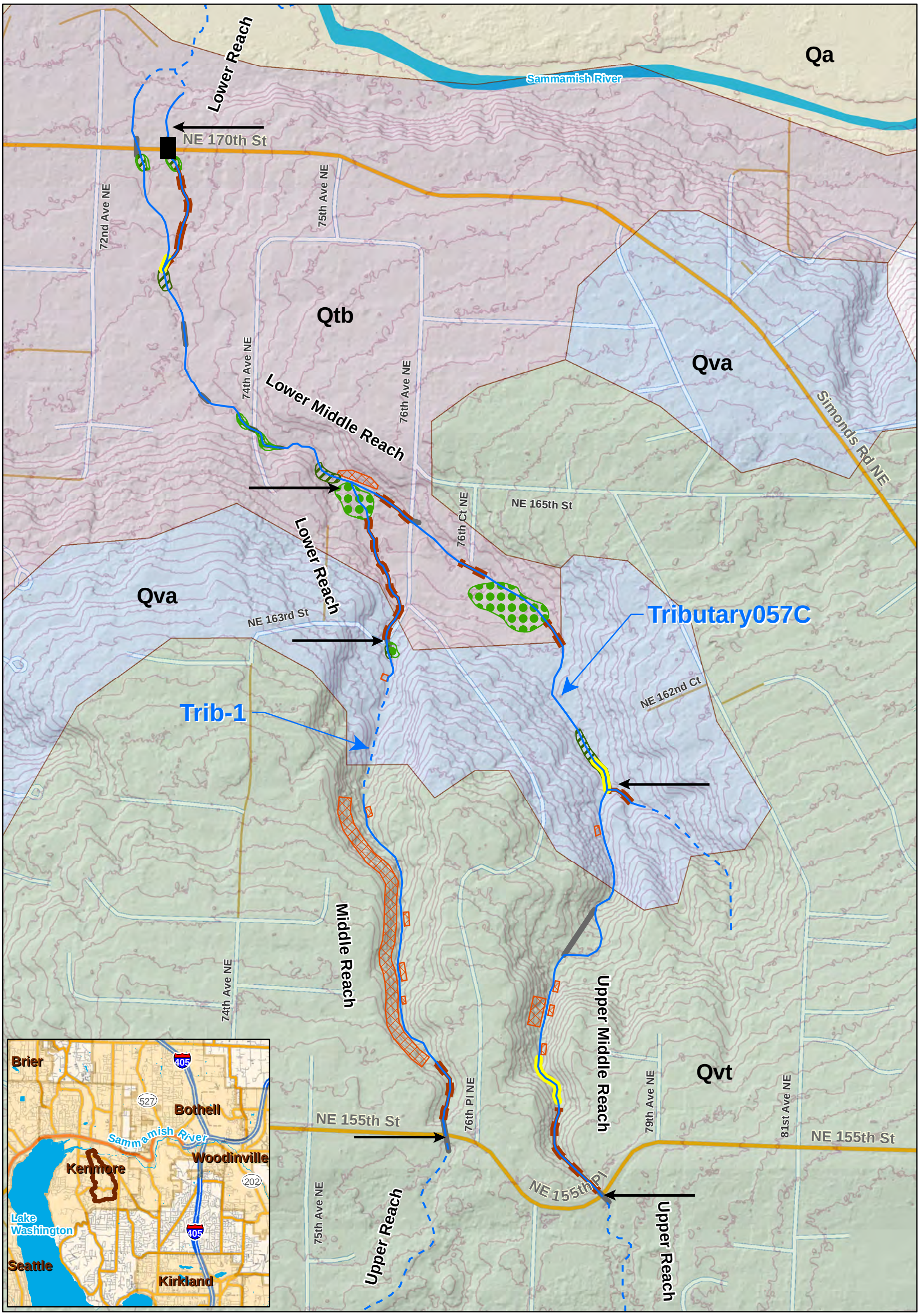


Base Information

- Channel Surveyed
- Channel Not Surveyed
- Reach Breaks
- 10 ft Contours
- Sediment Trap
- Culverts

Processes

- Lateral Incision
- Vertical Incision
- Deposition in Channel
- Deposition in Overbank
- Mass Wasting

Geology

- Qa - alluvium
- Qvt - continental glacial till
- Qva - advance outwash
- Qtb - transitional beds

N W E S

0 200 400 800 Feet

Figure 2-6 Active Processes

City of Kenmore Basin Sediment Study
Kenmore, WA

GeoEngineers

Gray & Osborne, Inc. Consulting Engineers

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

Reference: Field sketch data from GeoEngineers. Base data from ESRI and King County. Slopes and contours derived from LiDAR provided by King County. Data projected as NAD 83 HARN Stateplane Washington North (feet).

EXISTING PROBLEM AREAS

In determining locations of disposal of sediment, the existing stormwater system within Tributary 057 and its main tributary were walked to provide insight on the drainage problems. The locations of the problem areas are depicted on Figure 2-6. Lateral and vertical incisions, deposition in channels, and overbanks and mass wasting locations are indicated.

CHAPTER 3

HYDROLOGIC AND HYDRAULIC ANALYSIS

Hydrologic and hydraulic analysis of the City of Kenmore stormwater system was performed using the WHMM (Western Washington Hydrology Model) computer model and through field investigation. The WHMM computer program is capable of numerically modeling existing basin conditions as well as future land use conditions to determine existing and anticipated stormwater runoff. It is also capable of numerically modeling conveyance and detention/retention systems. The hydrologic/hydraulic model for the project area was developed to assess the capacity of the stormwater management system under historic and existing land use conditions.

MODELING BACKGROUND

Hydrologic analysis addresses the movement of rainfall to the conveyance system. The purpose of a hydrologic model is to predict the flow of stormwater runoff into the conveyance system. The input parameters to the model assume that within each hydrologic basin or collection area, there are discreet locations at which runoff enters the conveyance system, such as catch basins, culverts, and channels. In actuality, runoff enters a conveyance system at numerous locations; for example, any point along the entire length of a ditch. For these situations it was assumed that the runoff enters the system at a known point downstream and time of concentration values were adjusted accordingly. The information generated in the hydrologic model is presented in the form of a hydrograph, a standard plot of runoff (cubic feet per second) versus time (hours) for a given location and design storm event.

Hydrologic modeling methods require input parameters that describe physical drainage basin characteristics. Together with the distribution of rainfall over time, these parameters determine the shape of the resulting hydrograph generated by the model. Key parameters are the area of pervious and impervious surfaces, the interconnectivity of the impervious areas, topography, and infiltration characteristics of the soil. As part of the hydraulic modeling, stormwater conveyance information was obtained through the review of aerial surveys of the City, City records, City and King County GIS information, discussions with City staff and residents, a public open house, and data collected during field visits.

The basic steps in the development of the hydrologic or runoff model include:

- Development of rainfall intensity over time;
- Delineation of the drainage basins and subbasins;

- Identification of land use and estimation of the amount of pervious and impervious areas;

- Identification of soil types and estimation of the infiltration parameters; and

- Identification of topographic characteristics and estimation of flow parameters, including average slope, roughness coefficients, and depression storage.

Based upon these parameters, the model estimates the resulting runoff hydrograph from the project area. The runoff hydrographs are routed through the conveyance system and added together to provide inflow volumes. Hydraulic analysis is then used to determine the flow rates over the time of the design storm, including the peak flow rate for the event. The water surface elevations are determined over time throughout the conveyance system for a given storm event. Hydraulic analysis is based on the physical characteristics of the conveyance system, such as cross-sectional area, slope, and roughness.

DESIGN STORM

All storm event models require the input of data describing rainfall intensity over time. The WWHM incorporates over 40 years of rainfall data to generate flows.

For Western Washington design storm rainfall, both intensity at a given time and the total volume are described in the Washington State Department of Ecology *Stormwater Management Manual for Western Washington*. The 25-year modeled flow was used to size the conveyance system. The magnitudes of the design storms for Kenmore are below in Table 3-1.

MODELING RESULTS

The project area was modeled under historic conditions and existing conditions to see what increase in flow the developments within the project area have caused. See Figure 3-1 for a summary of these results. Tributary 057 is the main channel, and its main tributary (Trib-1) is the channel to the west. The results reflect a flow increase for the 100-year storm flow of 36.4 cubic feet per second (cfs) and 16.9 cfs for Tributary 057 and Trib-1, respectively.

The flow for each of the analysis areas was evaluated using WWHM. The upstream areas were modeled as existing condition as well as historic (forest) condition to evaluate the increase in flow at each point (see Figure 3-3). These calculated flows will aid in determining the proper sizing for facilities and appropriate measures required at each area analyzed.

Tributary 057 (East)

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	62.4
Pervious	C	Lawn	Moderate	101.3
Impervious	N/A	Road	Moderate	82.9

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	22.0202
5 Year =	27.8172
10 Year =	31.6754
25 Year =	36.5988
50 Year =	40.3125
100 Year =	44.0726

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	246.6

WWHM Output
(100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	4.3920
5 Year =	6.5424
10 Year =	7.1829
25 Year =	7.5350
50 Year =	7.6423
100 Year =	7.6922

Tributary-1 (West)

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	45.4
Pervious	C	Lawn	Moderate	47.1
Impervious	N/A	Road	Moderate	38.5

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	10.3646
5 Year =	13.1433
10 Year =	14.9981
25 Year =	17.3702
50 Year =	19.1630
100 Year =	20.9810

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	131

WWHM Output
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	2.3332
5 Year =	3.4755
10 Year =	3.8157
25 Year =	4.0028
50 Year =	4.0598
100 Year =	4.0863

FIGURE 3-1

Tributary 057 and 058 Stormwater Modeling Output

Sediment Trap Basin 1

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	7.1
Pervious	C	Lawn	Moderate	33.5
Impervious	N/A	Road	Moderate	27.4

WWHM Output
Existing condition

```
Flow(CFS)       0501
2 Year   =    7.1665
5 Year   =    9.0142
10 Year  =    10.2398
25 Year  =    11.7998
50 Year  =    12.9739
100 Year =    14.1607
```

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	68

WWHM Output
100% Forest condition (Type C Moderate Slope Forest)

```
Flow Frequency
Flow(CFS)       0501
2 Year   =    1.2111
5 Year   =    1.8041
10 Year  =    1.9807
25 Year  =    2.0778
50 Year  =    2.1074
100 Year =    2.1211
```

Sediment Trap Basin 2

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	16
Pervious	C	Lawn	Moderate	37.8
Impervious	N/A	Road	Moderate	30.9

WWHM Output
Existing condition

```
Flow Frequency
Flow(CFS)       0501
2 Year   =    8.1490
5 Year   =    10.2728
10 Year  =    11.6840
25 Year  =    13.4826
50 Year  =    14.8379
100 Year =    16.2090
```

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	84.7

WWHM Output
100% Forest condition (Type C Moderate Slope Forest)

```
Flow Frequency
Flow(CFS)       0501
2 Year   =    1.5085
5 Year   =    2.2471
10 Year  =    2.4671
25 Year  =    2.5881
50 Year  =    2.6249
100 Year =    2.6421
```

FIGURE 3-2

Stormwater Modeling Output for Hydrologic Areas 1 through 10

Sediment Trap Basin 3

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	43.0
Pervious	C	Lawn	Moderate	50.6
Impervious	N/A	Road	Moderate	41.4

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	11.0942
5 Year =	14.0533
10 Year =	16.0269
25 Year =	18.5495
50 Year =	20.4549
100 Year =	22.3862

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	135

WWHM Output (Sediment Trap Basin 3-East)
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	2.4044
5 Year =	3.5816
10 Year =	3.9322
25 Year =	4.1250
50 Year =	4.1837
100 Year =	4.2111

Sediment Trap Basin 4

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	100.6
Pervious	C	Lawn	Moderate	107.7
Impervious	N/A	Road	Moderate	88.2

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	23.7089
5 Year =	30.0550
10 Year =	34.2899
25 Year =	39.7051
50 Year =	43.7970
100 Year =	47.9459

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	296.5

WWHM Output (Tributary 057)
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	5.2808
5 Year =	7.8662
10 Year =	8.6364
25 Year =	9.0597
50 Year =	9.1888
100 Year =	9.2488

FIGURE 3-2 (continued)

Stormwater Modeling Output for Hydrologic Areas 1 through 10

Sediment Trap Basin 5

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	36.2
Pervious	C	Lawn	Moderate	37.2
Impervious	N/A	Road	Moderate	30.4

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	8.1873
5 Year =	10.3832
10 Year =	11.8491
25 Year =	13.7240
50 Year =	15.1410
100 Year =	16.5780

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	103.8

WWHM Output
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	1.8487
5 Year =	2.7538
10 Year =	3.0235
25 Year =	3.1717
50 Year =	3.2168
100 Year =	3.23

Sediment Trap Basin 6

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	36.2
Pervious	C	Lawn	Moderate	37.2
Impervious	N/A	Road	Moderate	30.4

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	8.1873
5 Year =	10.3832
10 Year =	11.8491
25 Year =	13.7240
50 Year =	15.1410
100 Year =	16.5780

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	103.8

WWHM Output
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	1.8487
5 Year =	2.7538
10 Year =	3.0235
25 Year =	3.1717
50 Year =	3.2168
100 Year =	3.2379

FIGURE 3-2 (continued)

Stormwater Modeling Output for Hydrologic Areas 1 through 10

Sediment Trap Basin 7

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	100.6
Pervious	C	Lawn	Moderate	111.2
Impervious	N/A	Road	Moderate	90.9

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	24.4145
5 Year =	30.9438
10 Year =	35.3003
25 Year =	40.8703
50 Year =	45.0789
100 Year =	49.3457

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	302.7

WWHM Output
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	5.3912
5 Year =	8.0307
10 Year =	8.8170
25 Year =	9.2492
50 Year =	9.3809
100 Year =	9.4422

Sediment Trap Basin 8

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	100.6
Pervious	C	Lawn	Moderate	148.0
Impervious	N/A	Road	Moderate	121.1

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	32.2453
5 Year =	40.7643
10 Year =	46.4373
25 Year =	53.6795
50 Year =	59.1444
100 Year =	64.6793

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	369.7

WWHM Output (Sediment Trap Basin 3-West)
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	6.5845
5 Year =	9.8082
10 Year =	10.7685
25 Year =	11.2964
50 Year =	11.4573
100 Year =	11.5321

FIGURE 3-2 (continued)

Stormwater Modeling Output for Hydrologic Areas 1 through 10

Sediment Trap Basin 9

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	107.8
Pervious	C	Lawn	Moderate	148.4
Impervious	N/A	Road	Moderate	121.4

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	32.3833
5 Year =	40.9613
10 Year =	46.6760
25 Year =	53.9740
50 Year =	59.4824
100 Year =	65.0626

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	377.6

WWHM Output (Sediment Trap Basin 3-West)
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	6.7252
5 Year =	10.0178
10 Year =	10.9986
25 Year =	11.5378
50 Year =	11.7021
100 Year =	11.7786

Sediment Trap Basin 10

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	107.8
Pervious	C	Lawn	Moderate	148.4
Impervious	N/A	Road	Moderate	121.4

WWHM Output
Existing condition

Flow Frequency

Flow(CFS)	0501
2 Year =	32.3833
5 Year =	40.9613
10 Year =	46.6760
25 Year =	53.9740
50 Year =	59.4824
100 Year =	65.0626

Per/Imp	Soil Type	Land Cover	Slope	Acreage
Pervious	C	Forest	Moderate	377.6

WWHM Output (Sediment Trap Basin 3-West)
100% Forest condition (Type C Moderate Slope Forest)

Flow Frequency

Flow(CFS)	0501
2 Year =	6.7252
5 Year =	10.0178
10 Year =	10.9986
25 Year =	11.5378
50 Year =	11.7021
100 Year =	11.7786

FIGURE 3-2 (continued)

Stormwater Modeling Output for Hydrologic Areas 1 through 10

Basin characteristics were established through field observation, Soil Conservation Service soil surveys, and topographical information provided from the aerial survey map.

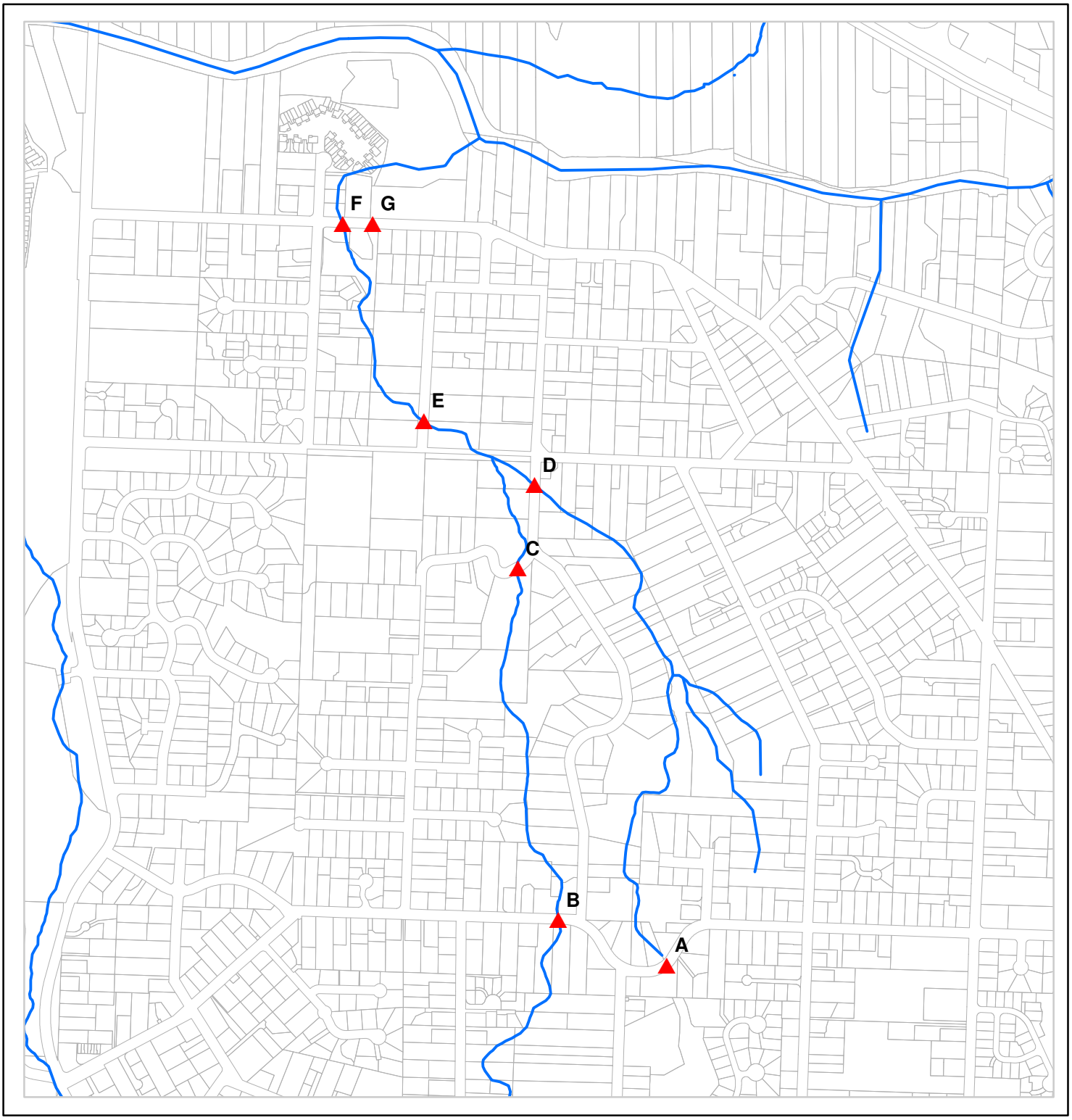
During the field investigation, numerous culverts under roads were encountered. A hydraulic analysis was completed to determine the maximum capacity based on Manning's equation (open-channel flow) of these culverts to compare to the 25- and 100-year storm events. Table 3-1 displays the results of the analysis. All the culverts except the culvert at 74th Avenue NE have sufficient hydraulic capacity. The existing 24-inch culvert at 74th Avenue NE should be replaced with a culvert sufficient to provide hydraulic capacity and will be required to meet fish passage requirements from WSDFW. Figure 3-3 depicts the locations of each of the culvert analysis.

TABLE 3-1

Culvert Capacity

Culvert ID	Location	Flow Capacity (cfs)	25-year Modeled Peak Flow (cfs)	100-year Modeled Peak Flow (cfs)
A	155th	26.61	11.8	14.2
B (1)	155th	19.85	13.7*	16.6*
C	163rd	27.8	13.7	16.6
D	76th	32.04	18.5	22.4
E	74th	36.12	40.9	49.4
F	170th	136.62	53.7	64.7
G	170th	362.92	53.7	64.7

(1) Modeled peak flows for Culvert B were taken from Culvert C as a conservative approach, as Culvert C is downstream from Culvert B where more area is flowing to, thus more runoff would be present.



LEGEND

- Culvert capacity checks
- Streams
- Roads
- Parcels

N

800 400 0 800 Feet

CITY OF KENMORE

TRIBUTARY 057 SEDIMENT STUDY

FIGURE 3-3

CULVERT CAPACITY ANALYSIS LOCATIONS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

L:\KENMORE\09517.00 Trib 57 Basin Sediment Study\GIS\Culvert Capacity Location Map.mxd - 6/10/2010 @ 1:23:45 PM

CHAPTER 4

SEDIMENT ANALYSIS AND CONTROL

INTRODUCTION

Sediment analysis is useful to evaluate modifications to a system and to determine ways to mitigate any adverse effects. It involves the study of sediments and the mechanisms by which they are transported, eroded, and deposited. By determining the types of sediment located at the sites, the biological and geological processes around them can be concluded.

BACKGROUND

The project follows Tributary 057 and its main unnamed tributary (Trib-1). The two channels converge at approximately NE 165th Street, and flow north into the Sammamish River and into Lake Washington. The project has an elevation difference of 450 feet, with a stream length of approximately 2 miles.

The project area is historically comprised of transitional beds (interbedded clay, silt, and sand), advance continental outwash (well-sorted clay, silt, and gravel), and till (stiff, generally impermeable soil). Alluvium (loose, unconsolidated soil) is also mapped in the Sammamish River floodplain as a recent supplement.

FIELD INVESTIGATION

In August 2009, a field investigation was conducted of Tributary 057. The following is a summary of GeoEngineers' Field Report for this investigation. The full field report is located in Appendix B.

PURPOSE

Conduct a geomorphic (earth surface configuration) assessment of sediment source and transport processes within Tributary 057, and to provide a quantitative approximation of sediment volumes delivered annually to the sediment trap located in NE 170th Street.

PROCEDURE

Tributary 057 and its main tributary (Trib-1) were surveyed. A measuring tape and hand level were used to measure channel cross sections and calculate the slope at numerous locations. Samples of the sediment were also collected from areas of erosion along each tributary. Observations were documented using field notes and photographs, which were linked to GPS data points.

SUMMARY OF OBSERVATIONS

Field examination reflected what the geological mapping had indicated. Alluvium was found to be deposited in the lower (north) region of the project near the Sammamish River, and the advance outwash was located in the middle and upper-middle sections while till was observed at the upper section of the drainage basin.

The upper section containing till was not considered a significant source of sediment, with a relatively low slope and residential development aiding in minimizing the amount of erosion and sediment delivery to reach downstream.

The advance outwash (middle and upper-middle sections) was the most notable regarding sediment deposition. It is composed of a sandy layer on top of a clay layer. When water infiltrates into the sandy layer, the sand grains will lose friction as water gets between each sand particle. When the water reaches the more impermeable clay layer, the water will flow on top of the clay layer to the point of discharge. This poses a significant potential for slope failure along the sand and clay layers.

The lower-middle and lower sections had few slope failures, and while lateral and vertical channel incisions were common, they were typically not severe. It was found that the lower-middle section had well-vegetated, flood-prone areas to accommodate overbank flow and to store sediment. The lower section flows north from NE 170th Street through a pipe into a wetland, where the combination of large sediment deposits and the shallow gradient has created poorly defined channels. This section has proven to be troublesome for the condominiums to the west of the project area (Wildcliffe Shores) as their finish floor elevation is lower than that of the stream.

The project area is largely developed by parcels, with undeveloped areas within the steep valley sections along most of the tributaries. Typically with an increase in development, there is an increase in runoff due to the added impervious area. Impervious areas will cause the runoff to reach the discharge point more quickly.

Even with the high density of residences in the area, the sediment source material was found to be dominantly derived from the natural landscape (slope failure), and a minor component of sediment was derived directly from residential sources (i.e., failures from house, yard, or road fill material).

ANALYSIS

Aside from the field investigation, additional sources were used to produce the sediment analysis. Sources include digitized aerial photographs, Lidar, geologic and topographic maps, critical hazard maps, and record drawings for existing structures such as the sediment vault in NE 170th Street. The information collected in GIS was used to layer the information to help assess the project area.

In determining the best locations/scenarios for a sediment trap, the following locations were determined by GeoEngineers to be suitable. The locations are ordered from the upstream end of the basin down to the confluence with the Sammamish River. See Figure 4-1 for a map of these areas within Tributary 057.

TABLE 4-1

Suitable Sediment Trap Locations

Area	Description
1	Detention facility at NE 155th Street
2	Sediment trap at private drive, 500 feet downstream of NE 155th Street
3	Within area with large quantities of deposition southeast of south end of 76th Court NE
4	On downstream side of culvert under 76th Avenue NE
5	Structural sediment vault on downstream side of culvert under NE 163rd Street
6	Natural sediment trap on downstream side of culvert under NE 163rd Street
7	Sediment trap on either side of 74th Avenue NE
8	Enlarge existing sediment trap in NE 170th Street
9	Removal of existing sediment trap and install box culvert and channel work in NGPE area (Tract C) of Wildcliffe Shores Condominiums
10	Removal of existing sediment trap and install open channel lined with ecology blocks and channel work in NGPE area (Tract C) of Wildcliffe Shores Condominiums

To further describe projects proposed in these areas, cost estimates for each are located in Table 4-2, with detailed cost breakdowns provided in Appendix D. Permits from the WSDFW and compliance with the City's Critical Areas Ordinance (KMC 18.55) will be required for all of the proposed projects. It is likely that U.S. Army Corps of Engineers and Washington State Department of Ecology permits will be required for the majority of projects as well. Figure 3-3 contains hydrologic information for each area.

- **Area 1 –** A detention facility is proposed on the upstream side of the culvert under NE 155th Street. This facility is not intended to trap sediment, but to control hydrology (reduce flow velocity). By reducing the flow, the amount of sediment being carried downstream would also be reduced. This location would require a detention facility of approximately 7,500 square feet and a 10-foot depth, in which acquisition of an easement on private property would be required as well as a drop in the invert elevation of the downstream end of the existing pipe under NE 155th Street for the required downward slope in the outlet pipe. The facility would reduce the 100-year storm event from 11.8 cfs to 10.3 cfs; a decrease of 1.5 cfs. For this facility to achieve its maximum volume, the culvert under NE 155th Street would require being dropped by approximately 4 feet, which requires work within the right-of-way of NE 155th Street. This

facility would be combined with a treatment method for Trib-1 to cover sediment treatment for the entire project area. The project cost is estimated to be $621,000.

- **Area 2 –** A sediment trap is proposed at the upstream or downstream end of the 24-inch culvert which runs under a private drive approximately 500 feet downstream of NE 155th Street. The sediment trap volume required would be at least 55 cubic yards. This facility would require an easement on private property and would be combined with a treatment method for Trib-1 to cover sediment treatment for the entire project area. The project cost is estimated to be $276,000.

- **Area 3 –** A natural sediment trap is proposed within a segment approximately 400 to 1,000 feet upstream of 76th Avenue NE. It is proposed that large pieces of wood be placed in the channel to promote overbank flooding and deposition. This requires temporary access onto private property to assemble the logs, but would require minimal access and maintenance from that point forward. This facility would be combined with a treatment method for Trib-1 to cover sediment treatment for the entire project area. The project cost is estimated to be $90,000.

- **Area 4 –** A structural sediment trap is proposed within a 400-foot segment on the downstream side of the culvert under 76th Avenue NE. The downstream end of culvert was chosen due to the ability to utilize the culvert to channel the flow to the facility. This requires temporary access onto private property to construct the facility and would require a permanent easement for maintenance access. This facility would be combined with a treatment method for Trib-1 to cover sediment treatment for the entire project area. The project cost is estimated to be $299,000.

- **Area 5 –** Construction of a sediment vault on the downstream side of the culvert crossing under NE 163rd Street is proposed. The culvert's downstream location was chosen due to the ability to utilize the culvert to channel flow to the facility. According to the GeoEngineers analysis, Trib-1 contributes the most sediment to the undersized sediment vault in NE 170th Street. The new sediment vault would store the sediment from the area contributing the most sediment and the existing sediment vault would continue to store the remaining sediment. This alternative in combination with the existing sediment vault within NE 170th Street would cover the Tributary 057 drainage basin. The project cost is estimated to be $520,000.

- **Area 6 –** Construction of a natural sediment trap on the downstream side of the culvert crossing under NE 163rd Street is proposed. The culvert's downstream location was chosen due to the existing meandering path of

the stream. According to the GeoEngineers analysis, Trib-1 contributes the most sediment to the undersized sediment vault in NE 170th Street. The new sediment trap would help store the sediment from the area contributing the most sediment and the existing sediment vault would continue to store the remaining sediment. This alternative in combination with the existing sediment vault within NE 170th Street would cover the Tributary 057 drainage basin. The project cost is estimated to be $162,000.

- **Area 7 –** A sediment trap is proposed to be constructed on either side of the culvert under 74th Avenue NE. This location allows for natural or structural sediment traps. The natural sediment trap would most likely be located upstream of the culvert, where a meandering stream already exists. This existing stream would be enhanced to be able to function fully as a sediment trap. The structural sediment trap could be located downstream of the culvert and would have a storage capacity of 125 cubic yards. By being downstream, the culvert would aid in channeling flow into the facility. This project would be located on private property and would require an easement for construction and maintenance. The project cost is estimated to be $477,000.

- **Area 8 –** Expansion of the existing sediment trap under NE 170th Street is proposed. The current sediment trap has proven to be undersized for the quantities of sediment produced upstream. Flooding has occurred due to the sediment trap overflowing in the past, even when regular maintenance to remove the sediment took place. The sediment trap is estimated to require a volume of 200 cubic yards. Along with an enlarged sediment trap, the outlet pipe would most likely need to be replaced. This option is located within public property, but is under a busy road within the City (NE 170th Street). The project cost is estimated to be $797,000.

- **Area 9 –** This area requires two separate projects: (a) removal of the existing sediment trap under NE 170th Street and construction of a box culvert in its place that is large enough to allow flows with sediment to pass through, and (b) construction of a channel within the NGPE area of Wildcliffe Shore Condominiums (Tract C) that broadens and shallows as well as meanders toward the Sammamish River promoting sediment deposition. There will be a sediment management area just north of the open channel outlet equipped with rootwad buttresses and quarry spalls to aid in the initial sediment trapping. Although the channel construction is located on private property like most of the other suitable areas, the Wildcliffe Shores Homeowners Association has been supportive thus far with ideas to alleviate flooding and sediment-related problems on their property and would presumably be cooperative to accommodate use of

this area if it were chosen as the site for improvements. The project cost is estimated to be $649,000.

- **Area 10 –** This area requires two separate projects. The first part of the project involves removal of the existing sediment trap under NE 170th Street and construction of an open channel lined with ecology blocks in its vicinity that is large enough to allow flows with sediment to pass through. This channel would be sized to be fish passable and the open channel would allow for a more natural setting. The alignment of the open channel would shift to the west slightly from the existing pipeline and run along the existing property line. The open channel would also be lined with a fence and trees for protection. The second part of the project includes construction of a channel within the NGPE area of Wildcliffe Shore Condominiums (Tract C) that broadens and shallows as well as meanders toward the Sammamish River promoting sediment deposition. There will be a sediment management area just north of the open channel outlet equipped with rootwad buttresses and quarry spalls to aid in the initial sediment trapping. Although the channel construction is located on private property like most of the other suitable areas, the Wildcliffe Shores Homeowners Association has been supportive thus far with ideas to alleviate flooding and sediment-related problems on their property and would presumably be cooperative to accommodate use of this area if it were chosen as the site for improvements. The project cost is estimated to be $558,000.

A cost estimate was done for each potential project site. Table 4-2 depicts these values. Cost estimate breakdowns are located in Appendix D.

TABLE 4-2

Cost Estimates

Area	Description	Cost Estimate
1	Detention facility at 155th	$621,000
2	Sediment trap at private drive	$276,000
3	Sediment trap near 76th	$ 90,000
4	Sediment trap at 76th	$299,000
5	Sediment vault at 163rd	$520,000
6	Sediment trap at 163rd	$162,000
7	Sediment trap at 74th	$477,000
8	Enlarge existing sediment trap	$797,000
9	Box culvert at 170th	$649,000
10	Ecology blocks at 170th	$558,000

CHAPTER 5

CAPITAL IMPROVEMENTS AND PROGRAM PLAN

INTRODUCTION

Recommendations for sediment management within the City are presented in this chapter. The recommended projects include structural and nonstructural elements to control the quantity of sediment buildup.

Based on the findings of this study, the existing sediment vault at NE 170th Street and 72nd Avenue NE is insufficient to provide effective management of the sediment load produced upstream. Potential project areas were investigated during the field investigation and solutions are presented.

This chapter also discusses existing and proposed stormwater management program activities that should continue or should start to take effect. In order to fully account for necessary City stormwater management program activities and their costs, the analysis includes existing Public Works Department road drainage operation and maintenance activities. New stormwater management program activities are also proposed. They include:

- Inspection of private stormwater management facilities, and
- Public education and outreach activities.

PROJECT RANKING

To evaluate the most appropriate measures to pursue in the basin City staff and Gray & Osborne devised a ranking methodology. The methodology addressed issues raised during the public meetings, sediment evaluation, and field investigations. A point score of 1 to 5 was given to each category, with 1 being more expensive or of least benefit and 5 being of least cost or higher benefit. The categories are as follows:

- **Maintenance Frequency Cost –** The cost of maintaining each alternative was considered. Though actual costs were not derived, the anticipated frequency of maintenance was evaluated over a 5-year period. More frequent maintenance received lower points with one maintenance event over 5 years receiving 5 points.

- **Environmental Benefit –** The potential improvement to the environment was evaluated. Typical improvements included water quality, improved plant habitat, improved fish habitat, etc.

- **Effort to Permit/Permit Requirements –** The number of permits and complexity of preparing and obtaining approval were considered. The more permits and complexity, the lower the point score.

- **Design Effort/Technical Complexity –** Lower scores were given to projects requiring considerable design effort and higher scores to projects requiring little analysis.

- **Project Capital Costs –** Lower scores were given to projects with the highest capital cost and higher scores to projects with low capital costs.

- **Sediment Management Benefit –** Projects that significantly reduced the impact of sediment or reduced sediment loads were given higher scores as compared to projects that only had minor reductions in sediment load or impacts.

Table 5-1 depicts the results for this analysis.

TABLE 5-1

Project Area Evaluation

Project Area	1	2	3	4	5	6	7	8	9	10
Maintenance Frequency Cost	5	2	2	2	3	2	2	4	5	5
Environmental Benefit	2	3	2	3	3	3	4	3	4	5
Effort to Permit/Permit Requirements	4	4	3	3	3	3	3	3	2	2
Design Effort/Technical Complexity	4	3	3	3	3	3	3	3	2	2
Project Capital Cost	1	3	5	3	2	3	2	1	1	1
Sediment Management Benefit	1	1	2	2	4	3	3	4	5	5
Total	**17**	**16**	**17**	**16**	**18**	**17**	**17**	**18**	**19**	**20**

Each project is evaluated with a value between 1 and 5 in each category, with 5 being the best score (greatest benefit or lowest cost). The totals are out of 30, and Project Area 10 has the best scores, meaning the best overall alternatives for this project. The categories all have equal weight, which is not necessarily justified, but it provides a means of comparing the strengths and weaknesses of each proposed project and in aiding in determining which areas to study in more detail. The analysis of Areas 5, 8, 9, and 10, which have the highest ratings after the evaluation have been provided.

ALTERNATIVE ANALYSIS

After ranking the various projects, four alternatives were chosen for further consideration:

N

200 100 0 200 Feet

CITY OF KENMORE
TRIBUTARY 057 SEDIMENT STUDY
FIGURE 5-1
ALTERNATIVE 8, 9 & 10 LOCATIONS MAP

Gray & Osborne, Inc.
CONSULTING ENGINEERS

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N

200 100 0 200 Feet

CITY OF KENMORE
TRIBUTARY 057 SEDIMENT STUDY
FIGURE 5-2
ALTERNATIVE 5 LOCATION MAP

Gray & Osborne, Inc.
CONSULTING ENGINEERS

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CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 5 - STRUCTURAL SEDIMENT TRAP AT NE 163RD ST
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 21,400.00	$ 21,400.00
2	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
3	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
4	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	2-01.5	Clearing and Grubbing	0.10 AC	$ 7,000.00	$ 707.07
7	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Drainage Channel, Incl. Haul	100 CY	$ 12.00	$ 1,200.00
8	2-03.5	Unsuitable Foundation Excavation	5 CY	$ 50.00	$ 250.00
9	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10	2-03.5	Bank Run Gravel for Trench Backfill	292 TN	$ 25.00	$ 7,298.72
11	2-12.5	Construction Geotextile for Soil Stabilization	200 SY	$ 3.00	$ 600.00
12	7-08.5	Dewatering	1 LS	$ 10,000.00	$ 10,000.00
13	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,500.00	$ 1,500.00
14	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
15		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
16	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	70 LF	$ 131.00	$ 9,170.00
17	2-02.3(4)	Sawcutting	240 LF	$ 3.00	$ 720.00
18	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	11 SY	$ 110.00	$ 1,210.00
19	4-04.5	Crushed Surfacing Base Course	15 TN	$ 35.00	$ 513.33
20	4-04.5	Crushed Surfacing Top Course	11 TN	$ 25.00	$ 275.00
21		Asphalt Treated Base	7 TN	$ 110.00	$ 806.67
22	8-02.5	Landscape Removal/Restoration	1 LS	$ 2,400.00	$ 2,400.00
23	6-06.5	Precast Concrete Sediment Vault	1 LS	$187,500.00	$ 187,500.00
		Subtotal			$ 272,850.79
		Sales Tax at 8.5%			$ 23,192.32
		Subtotal, Estimated Construction Cost			$ 296,043.11
		Construction Cost Estimate			***$ 297,000.00***
		Contingency (30% of Construction Cost)			$ 89,100.00
		Engineering, Legal and Administration			$ 74,250.00
		Construction Management			$ 44,550.00
		Permitting			$ 14,850.00
		Project Cost Estimate			**$ 520,000.00**

Figure 5-3 - Construction Cost Estimates

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 8 - ENLARGE EXISTING SEDIMENT TRAP (NE 170th ST)
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 32,800.00	$ 32,800.00
2	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
3	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
4	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
5	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
6	2-02.5	Removal of Structure and Obstructions	1 LS	$ 5,000.00	$ 5,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1 LS	$ 2,000.00	$ 2,000.00
8	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
9	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Sediment trap facility (Incl. Haul)	1,155 CY	$ 12.00	$ 13,860.00
10	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
11		Reconnect to Existing Storm Drainage System	3 EA	$ 1,000.00	$ 3,000.00
12	7-17.3(3)	Bank Run Gravel for Trench Backfill	133 CY	$ 25.00	$ 3,333.33
13	2-03.5	Unsuitable Foundation Excavation	20 CY	$ 50.00	$ 1,000.00
14		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
15	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	70 LF	$ 131.00	$ 9,170.00
16	2-02.3(4)	Sawcutting	302 LF	$ 3.00	$ 906.00
17	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	77 SY	$ 110.00	$ 8,466.64
18	4-04.5	Crushed Surfacing Base Course	12 TN	$ 35.00	$ 423.50
19	4-04.5	Crushed Surfacing Top Course	46 TN	$ 25.00	$ 1,154.54
20		Asphalt Treated Base	31 TN	$ 110.00	$ 3,386.66
21		Remove/Replace Concrete Sidewalk	12 SY	$ 50.00	$ 611.11
22	8-04	Remove/Replace Concrete Curb and Gutter	22 LF	$ 50.00	$ 1,100.00
23	8-22	Restore Pavement Marking	1 LS	$ 100.00	$ 100.00
24	8-02.5	Landscape Removal/Restoration	1 LS	$ 5,000.00	$ 5,000.00
25	6-06.5	Precast Concrete Sediment Vault	1 LS	$ 300,000.00	$ 300,000.00
26	8-15.5	Quarry Spalls	11 TN	$ 35.00	$ 385.00
27	7-08.3(1)C	Compaction Testing	1 EA	$ 12.00	$ 12.00
		Subtotal			$ 418,508.78
		Sales Tax at 8.5%			$ 35,573.25
		Subtotal, Estimated Construction Cost			$ 454,082.03
		Construction Cost Estimate			***$ 455,000.00***
		Contingency (30% of Construction Cost)			$ 136,500.00
		Engineering, Legal and Administration			$ 113,750.00
		Construction Management			$ 68,250.00
		Permitting			$ 22,750.00
		Project Cost Estimate			**$ 797,000.00**

Figure 5-3 - Construction Cost Estimates

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 9 - BOX CULVERT CONSTRUCTION & NATURAL SEDIMENT TRAP W/IN TRACT C (WILDCLIFFE
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 25,700.00	$ 25,700.00
2	2-01.5	Clearing and Grubbing	0.13 AC	$ 7,000.00	$ 883.84
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1 LS	$ 2,000.00	$ 2,000.00
8	2-02.5	Removal of Structure and Obstructions	1 LS	$ 7,000.00	$ 7,000.00
9	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading - For Sediment trap and Trench (Incl. Haul)	1,000 CY	$ 12.00	$ 12,000.00
11	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
12	7-17.3(3)	Bank Run Gravel for Trench Backfill	453 CY	$ 25.00	$ 11,325.93
13	2-03.5	Unsuitable Foundation Excavation	53 CY	$ 50.00	$ 2,666.67
14		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
15	2-02.3(4)	Sawcutting	264 LF	$ 3.00	$ 792.00
16	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	13 TN	$ 110.00	$ 1,452.00
17	4-04.5	Crushed Surfacing Base Course	18 TN	$ 35.00	$ 616.00
18	4-04.5	Crushed Surfacing Top Course	26 TN	$ 25.00	$ 660.00
19		Asphalt Treated Base	9 TN	$ 110.00	$ 968.00
20		Remove/Replace Concrete Sidewalk	15 SY	$ 50.00	$ 733.33
21	8-04	Remove/Replace Concrete Curb and Gutter	26 LF	$ 30.00	$ 792.00
22	8-22	Restore Pavement Marking	33 LF	$ 0.50	$ 16.50
23	8-02.5	Landscape Removal/Restoration	1 LS	$ 5,000.00	$ 5,000.00
24	8-02.5	Topsoil Type A	40 CY	$ 40.00	$ 1,600.00
25		Streambank Stabilization and Restoration	1 LS	$ 10,000.00	$ 10,000.00
26	8-02.5	Root Wad Buttress	500 SF	$ 50.00	$ 25,000.00
27	6-06.5	Precast 8' x 8' Box Culvert (incl bedding)	230 LF	$ 800.00	$ 184,000.00
28		Reconnect to Existing Storm Drainage System	1 EA	$ 1,000.00	$ 1,000.00
29	8-15.5	Quarry Spalls (Outlet Pad and Rock Check Dams)	10 TN	$ 35.00	$ 350.00
30	8-02.5	Seeding, Fertilizing and Mulching	350 SY	$ 4.00	$ 1,400.00
31		Minor Changes	1 LS	$ 5,000.00	$ 5,000.00
		Subtotal			$ 327,756.26
		Sales Tax at 8.5%			$ 27,859.28
		Subtotal, Estimated Construction Cost			$ 355,615.55
		Construction Cost Estimate			***$ 356,000.00***
		Contingency (30% of Construction Cost)			$ 106,800.00
		Easement acquisition*	3,750 SF	$ 6.84	$ 25,650.00
		Engineering, Legal and Administration			$ 89,000.00
		Construction Management			$ 53,400.00
		Permitting			$ 17,800.00
		Project Cost Estimate			**$ 649,000.00**

*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

Figure 5-3 - Construction Cost Estimates

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 10 - ECOLOGY BLOCK WALL CONSTRUCTION & NATURAL SEDIMENT TRAP W/IN TRACT C
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY		UNIT PRICE		AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1	LS	$ 21,200.00	$	21,200.00
2	2-01.5	Clearing and Grubbing	0.20	AC	$ 7,000.00	$	1,400.00
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1	LS	$ 5,000.00	$	5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1	LS	$ 1,500.00	$	1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1	LS	$ 2,800.00	$	2,800.00
6	8-01.5	Temporary Erosion/Water Pollution Control	1	LS	$ 1,000.00	$	1,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1	LS	$ 2,000.00	$	2,000.00
8	2-02.5	Removal of Structure and Obstructions	1	LS	$ 7,000.00	$	7,000.00
9	2-03.5	Temporary Bypass/Diversion	1	LS	$ 10,000.00	$	10,000.00
10	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading - For Sediment trap and Trench (Incl. Haul)	1,000	CY	$ 12.00	$	12,000.00
11	1-07.17	Locate and Protect Existing Utilities	1	LS	$ 1,500.00	$	1,500.00
12	7-17.3(3)	Bank Run Gravel for Trench Backfill	460	CY	$ 25.00	$	11,500.00
13	2-03.5	Unsuitable Foundation Excavation	55	CY	$ 50.00	$	2,750.00
14		Sanitary Sewer Crossing Encasement	1	LS	$ 5,000.00	$	5,000.00
15	2-02.3(4)	Sawcutting	265	LF	$ 3.00	$	795.00
16	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	20	TN	$ 110.00	$	2,200.00
17	4-04.5	Crushed Surfacing Base Course	35	TN	$ 30.00	$	1,050.00
18	4-04.5	Crushed Surfacing Top Course	35	TN	$ 35.00	$	1,225.00
19		Asphalt Treated Base	15	TN	$ 110.00	$	1,650.00
20		Remove/Replace Concrete Sidewalk	15	SY	$ 50.00	$	750.00
21	8-04	Remove/Replace Concrete Curb and Gutter	30	LF	$ 30.00	$	900.00
22	8-22	Restore Pavement Marking	35	LF	$ 0.50	$	17.50
23	8-02.5	Landscape Removal/Restoration	1	LS	$ 5,000.00	$	5,000.00
24	8-02.5	Topsoil Type A	40	CY	$ 40.00	$	1,600.00
25		Streambank Stabilization and Restoration	1	LS	$ 10,000.00	$	10,000.00
26	6-06.5	Precast 8' x 8' Box Culvert (incl bedding)	75	LF	$ 850.00	$	63,750.00
27	8-02.5	Root Wad Buttress	500	SF	$ 50.00	$	25,000.00
28		Reconnect to Existing Storm Drainage System	1	EA	$ 1,000.00	$	1,000.00
29		Ecology Blocks	2,580	SF	$ 25.00	$	64,500.00
30	8-15.5	Quarry Spalls (Outlet Pad and Rock Check Dams)	10	TN	$ 35.00	$	350.00
31	8-02.5	Seeding, Fertilizing and Mulching	200	SY	$ 4.00	$	800.00
32		Minor Changes	1	LS	$ 5,000.00	$	5,000.00
		Subtotal				$	270,237.50
		Sales Tax at 8.5%				$	22,970.19
		Subtotal, Estimated Construction Cost				$	293,207.69
		Construction Cost Estimate				***$***	***294,000.00***
		Contingency (30% of Construction Cost)				$	88,200.00
		Easement acquisition*	5,650	SF	$ 7.57	$	42,770.50
		Engineering, Legal and Administration				$	73,500.00
		Construction Management				$	44,100.00
		Permitting				$	14,700.00
		Project Cost Estimate				**$**	**558,000.00**

*Easement acquisition value equation = sum of Easement area/sum of Parcel area * Parcel value per King County Assessors*75%

Figure 5-3 - Construction Cost Estimates

Figure 5-4 - Alternative Analysis	
Criteria	**Description**
Maintenance Frequency Cost	Every Five Years (5-1) Every year
Environmental Benefit	Improves WQ, minor erosion, adds plants, etc (5-1) Low
Effort to Permit/Permit requirements	Federal, State and City permits (5-1) Simple city permits
Design Effort/Technical complexity	Requires limited analysis (5-1) Requires complex analysis
Project Capital Cost	$50k or lower (5-1) $500k or higher
Potential Flooding Reduction Benefit	Reduces greatly (5-1) Reduces little

- **Alternative 10 –** Remove the existing sediment vault in NE 170th Street and existing pipe running north from the vault. The pipe to the west of the vault would also be abandoned. An open channel lined with ecology blocks would be constructed to run near the existing downstream pipe of the sediment vault in NE 170th Street. Additional easement would be required to be acquired from the property owner for the open channel as well as the access easement, which would run along the entire channel to access the sediment trap within Tract C of Wildcliffe Shores Condominiums. See Figure 5-1 for the location of this alternative. The project cost estimate is $558,000 (see Appendix D).

- **Alternative 9 –** Remove the existing sediment vault in NE 170th Street and existing pipe running north from the vault. The pipe to the west of the vault would also be abandoned. A box culvert would be constructed that runs north from the location of existing sediment vault to the wetland through the existing 20-foot drainage easement to convey surface water and sediment load to the Sammamish River floodplain. The existing drainage easement contains pipes and catch basins that will be removed with this project. See Figure 5-1 for the location of this alternative. The project cost estimate is $649,000 (see Appendix D).

- **Alternative 8 –** Enlarge the existing sediment trap in NE 170th Street to trap the sediment from project area. With more volume to store sediment, the sediment accumulation at the upstream end of the vault would not occur, and the potential of flooding would be considerably reduced provided routine maintenance continues. This project would require the reconnection of two existing pipes from the existing system, and the abandonment of one pipe. Due to the expansion of the vault size, pipes would be reduced in length. See Figure 5-1 for the location of this alternative. The project cost estimate is approximately $797,000 (see Appendix D). The current cost of maintaining the existing sediment vault is $6,000 each time the vault is emptied. In some years, the vault has been emptied twice.

- **Alternative 5 –** Construct a new sediment vault at the downstream point of the culvert under NE 163rd Street to capture sediment from the western upper tributary. This vault should be sized to a volume of 61 cubic yards per the sediment analysis by GeoEngineers. This vault would be placed along Trib-1, which is the source of the majority of sediment loads (per the sediment analysis by GeoEngineers). The existing sediment trap would remain in NE 170th Street and would function in its existing condition. See Figure 5-2 for the location of this alternative. The project cost estimate is $520,000 (see Appendix D). The current cost of maintaining the existing sediment vault is $3,000 each time the vault is emptied. In some years, the vault has been emptied twice.

RECOMMENDED ALTERNATIVE

Several criteria were used in evaluating the alternatives. Table 5-2 describes the alternatives ranked in Table 5-3. See Figure 5-3 for Alternatives 10, 9, 8, and 5 cost estimate breakdowns.

TABLE 5-2

Recommended Alternative Project Area Description

Alt.	Project Area
10	Ecology blocks at 170th
9	Box culvert at 170th
8	Enlarge existing sediment trap
5	Sediment vault at 163rd

TABLE 5-3

Recommended Alternative Project Area Evaluation

Recommended Alternative	10	9	8	5
Maintenance Frequency Cost	5	5	4	3
Environmental Benefit	5	4	3	3
Effort to Permit/Permit Requirements	2	2	3	3
Design Effort/Technical Complexity	2	2	3	3
Project Capital Cost	1	1	1	2
Sediment Management Benefit	5	5	4	4
Total	**20**	**19**	**18**	**18**

Alternative 10 (open channel with ecology blocks) has the highest rating after the evaluation. There is an environmental benefit to the open channel of being fish passable and it will be an open channel lined with trees for a more natural setting while enhancing the downstream wetland area. The open channel will also reduce operation and maintenance costs in the future relative to the existing sediment vault. The sediment vault requires annual, if not semi-annual, maintenance whereas the open channel's maintenance will be relatively minimal.

Gray & Osborne and City staff met with the WSDFW area habitat biologist to discuss these alternatives. WSDFW preferred Alternative 10 or 9, as it would allow the storm drainage system to be fish passable after construction. They expressed dissatisfaction with Alternative 8 and were impartial to Alternative 5. In addition, they noted that the culvert under 74th Avenue NE should be replaced no matter where the sediment control project takes place. Sediment does not seem to be a problem in this area, but large

quantities of water flowing through is a problem and the culvert is not able to handle these flows.

The permitting for Alternative 10 is one of the most involved, requiring compliance with the City's Critical Area Ordinance as well as a permit from the Washington State Department of Ecology and WSDFW. A permit from the U.S. Army Corps of Engineers for the work in the wetland is anticipated, although a wetland delineation has not been completed at this time. Even though the U.S. Army Corps of Engineers permit probably would be the most time-consuming, the outcome of having the sediment trap within the wetland is the most beneficial facility for the purpose of Alternative 10. An easement will be required for the open channel, as well as the access and drainage easement for the sediment management area. There is an existing drainage easement for the existing storm drainage system, but it will need to be realigned and enlarged for the open channel. An estimate for the easement acquisition is included in the project cost estimate.

As-built drawings of the existing sediment vault and associated upstream and downstream pipes are located in Appendix E. Per these King County as-built drawings, there will be three storm drainage manholes and three pipe spans that will be removed and replaced by the open channel. There is also a pipe to the west of the existing sediment vault which will be abandoned. This abandoned pipe currently functions as a route for flows to get from the sediment trap to the stream, deemed a fish-bearing stream by WSDFW, running just west of the proposed open channel.

Although the abandonment of this pipe would diminish flows in the existing fish-bearing stream considerably, the size of the proposed open channel will make this new channel fish passable, creating a new fish-bearing stream and providing fish passage to upstream habitat. The flows from this adjacent existing stream and the proposed open channel stream intersect in the Sammamish River floodplain associated with the Wildcliffe Shore condominiums. Additional land may be required to increase the existing storm drainage easement area to accommodate space for the vegetation or a more efficient route for the open channel to the outfall. The reduced flows of the adjacent existing stream will also relieve the northern properties of the chronic flooding and erosion problems. In addition, if this pipe were to remain to feed flow to the westerly stream, a flow splitter would be required. This would reduce the effectiveness of sediment trapping due to the sediment load being limited at the control structure and the current problem of sediment accumulation leading to flooding would continue.

Recommending Alternative 10 for this project would create a fish-bearing stream, while abandoning the pipe to the west to alleviate the flooding and erosion problems caused by a combination of sediment buildup and substantial volumes of water.

The second recommended alternative would be the construction of the box culvert (Alternative 9). The project is similar to that of the open channel, except as discussed above, the cost is slightly more and would not allow riparian habitat within the box culvert. The proposed box culvert would run along the existing pipeline (to be removed)

and outfalls into the Sammamish River floodplain associated with the Wildcliffe Shore condominiums, to the north of the existing sediment vault. The size of the box culvert is approximated to be 8 feet by 8 feet to accommodate the flows and sediment load created by the upstream tributary areas. Grating is proposed on top of the box culvert to provide lighting and leaf litter as well as vegetation along it to recreate a more natural setting. An easement would not be required for the box culvert portion of the project, as the existing storm drainage easement will be utilized, but the sediment management area to the north would require an easement. The maintenance, similar to that of the open channel, would be minimal compared with the existing sediment trap in NE 170th Street.

During the field investigation, a portion of the existing stream just south (upstream) of the existing sediment vault was found to be severely incised and not conducive as a fish-bearing stream. It is recommended to improve this portion of the stream to be deemed fish passable. The incised portion of the stream is located on private property behind the residence at 16910 72nd Avenue NE (Tax Parcel No. 5634500005). Cost estimates have not been prepared for this improvement plan.

In addition to these recommendations, the City should consider implementing future control and energy dissipation of public and private surface water collection and conveyance systems wherever possible. This will aid in reducing flow volume and velocity to lessen the scouring currently taking place. Examples of public locations include the two culvert discharges under NE 155th Street which have significant scouring on both outlet locations. Private location examples include downspout and drainage outfalls of private properties along the ravines within the tributary basin which could be tightlined down the hillside close to the stream and dispersed to limit erosion. Several private pipe outlets along the stream alignment were perched several feet above the streambed, which result in high energy and erosive discharges.

FUNDING

The City of Kenmore adopted an updated Surface Water Management Plan and Capital Improvement Project List in 2008. The CIP plan set aside $500,000 to design and construct capital improvement projects that came out of this study ($250,000 in 2010 and $250,000 in 2011). The City's capital improvement plan is funded by established surface water management fees. Because the cost of the recommended alternative exceeds the available budget either this project or some other project would need to be delayed until sufficient funds could be accumulated.

APPENDIX A

DRAINAGE COMPLAINTS

KING COUNTY WATER AND LAND RESOURCE DIVISION

DRAINAGE INVESTIGATION REPORT

Page 2: INVESTIGATION REPORT

SITE SKETCH, AND REPORT PREPARED BY: RICK THOMPSON

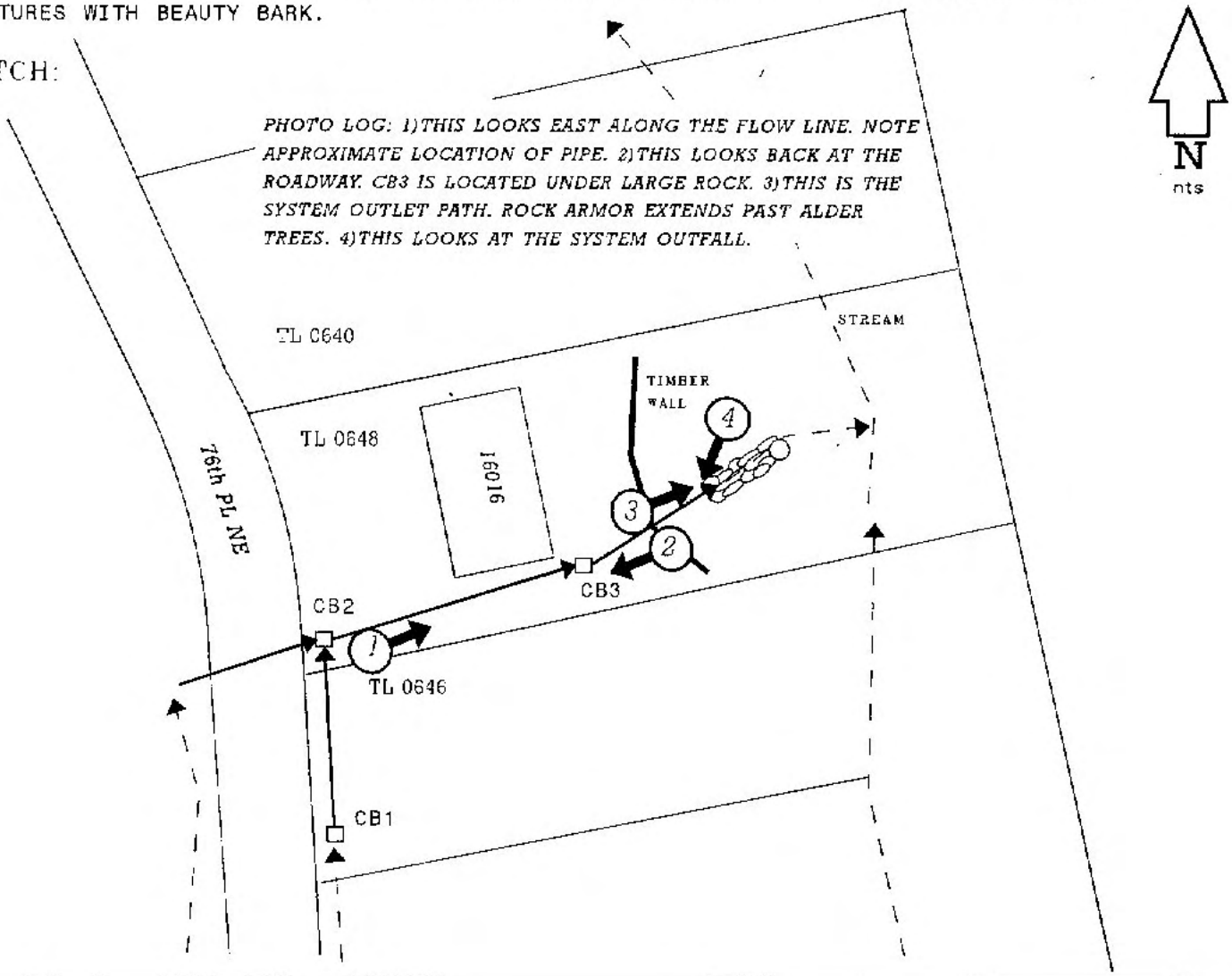
REPORT: JARVIS 99-0656

MET MRS JARVIS AT THE SITE ON 9/17/99. THE JARVIS HOME IS SITUATED ON A STEEP HILLSIDE. A ROAD SD CONVEYANCE SYSTEM IS LOCATED ON THE SOUTH SIDE OF THE RESIDENCE. MRS JARVIS WANTS ASSURANCES THE SYSTEM IS FUNCTIONAL. THE SD SYSTEM IS COMPRISED OF THREE CATCH BASINS AND A PIPE. THE PIPE CARRIES FLOW FROM THE ROAD DITCH ON THE WEST SIDE OF 76th PL NE. THE DITCH SERVES THE AREA SOUTH OF THE JARVIS HOME. THE DITCH, ITS OUTLET PIPE, CB's 1&2, AND THE OUTLET PIPE FROM CB2 ARE APPARENTLY MAINTAINED BY THE CITY OF KENMORE. THE DITCH NEEDS TO BE MOWED. CB2 WAS PARTIALLY BURIED IN BEAUTY BARK. OTHER THAN THAT, THIS PORTION OF THE SYSTEM IS IN GOOD WORKING ORDER.

THE REMAINING PORTION OF THE CONVEYANCE SYSTEM IS PRIVATE. CB3 IS A HOMEMADE TYPE ONE BASIN. IT WAS BURIED UNDER A LARGE ROCK SLAB. IT APPEARS THE ROOF DRAINS ARE STUBBED TO THE BASIN. THE BASIN INTERIOR LOOKS GOOD. THIS BASIN OUTLETS TO A NATURAL SWALE EAST OF THE JARVIS HOME. THE SWALE IS HEAVILY ROCKED WITH 4 TO 6" RIP RAP. THE ROCK EXTENDS A SHORT DISTANCE DOWNSLOPE FROM THE OUTLET. THERE IS MINOR DOWN CUTTING BELOW THE END OF THE ROCK ARMOR.

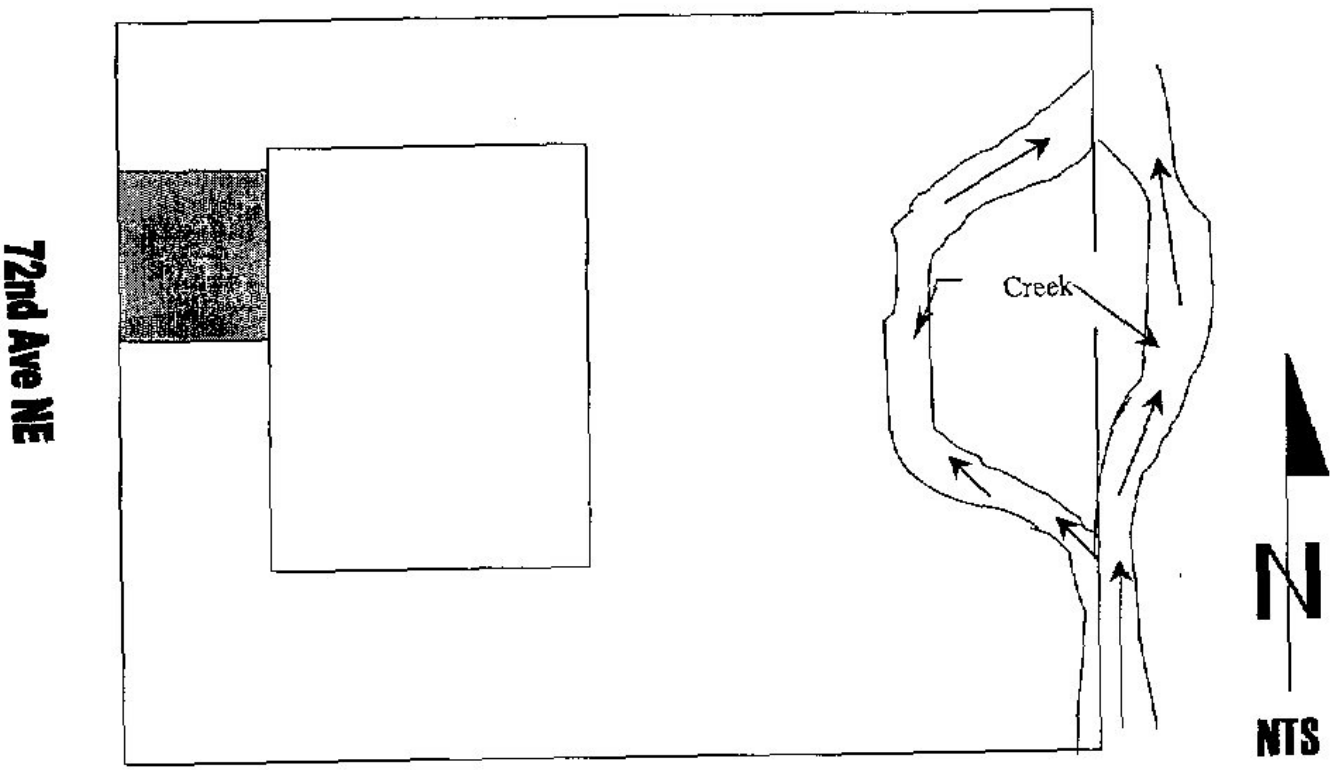
I TOLD MRS JARVIS TO INSPECT THE PRIVATE PORTIONS OF THE SYSTEM ROUTINELY. I TOLD HER TO MAKE SURE THE ROOF DRAIN DOWNSPOUTS WERE CONNECTED TO THE OUTLET PIPES. I TOLD HER TO USE ROCK TO COVER EXPOSED SURFACES WHERE EROSION COULD OCCUR. I ASKED HER TO STOP COVERING PUBLIC STRUCTURES WITH BEAUTY BARK.

SKETCH:



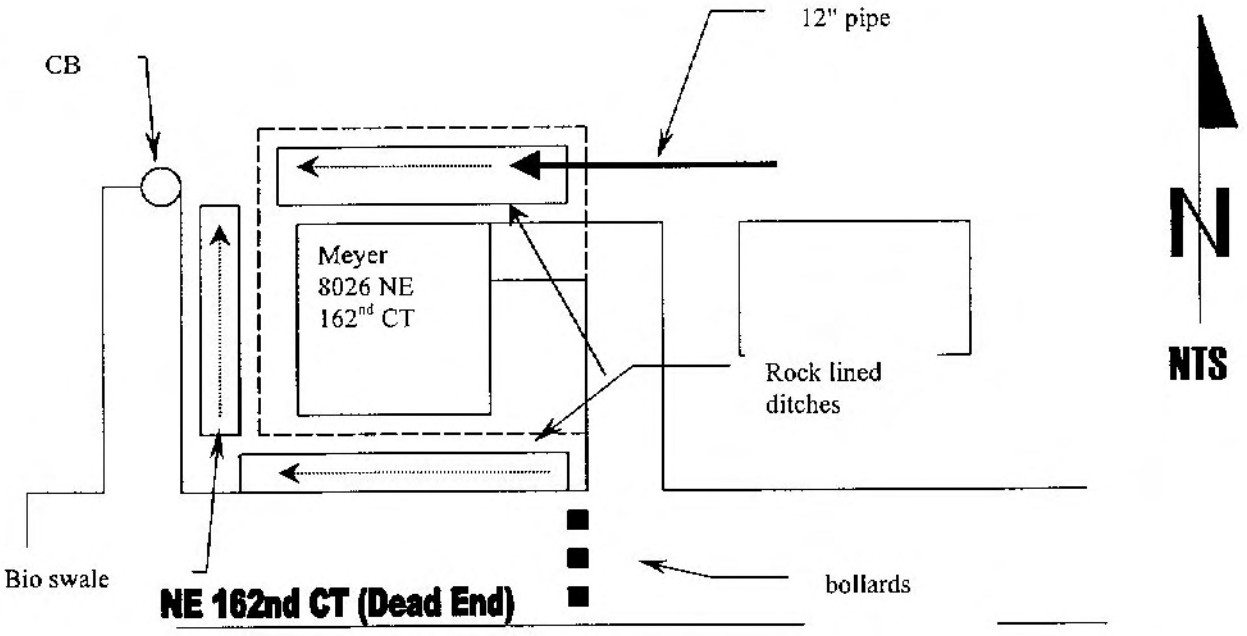
Complaint 00-00213 Marano
Investigated by Chris Treichel 03/31/00

Received a call from Larry Gettle for possible construction debris washing down an existing creek. Met with Mr. Marano at the site. He has a little creek through his back yard that runs from south to north off of the upper portion of Kenmore. It then flows into the Sammamish slough. When I arrived there was no debris in the creek. Mr. Marano said that it had been in the water and he was glad that it wasn't there. I looked along the banks for any evidence of materials that might have hooked on any roots or grasses. I could not locate anything. I gave Mr. Marano my card with my cellular number and told him that if he sees anything else in the creek that he should call me right away and I will be there as soon as possible. After leaving his property I drove around trying to follow the creek path but did not see any construction activity anywhere up stream that could be causing the problem.



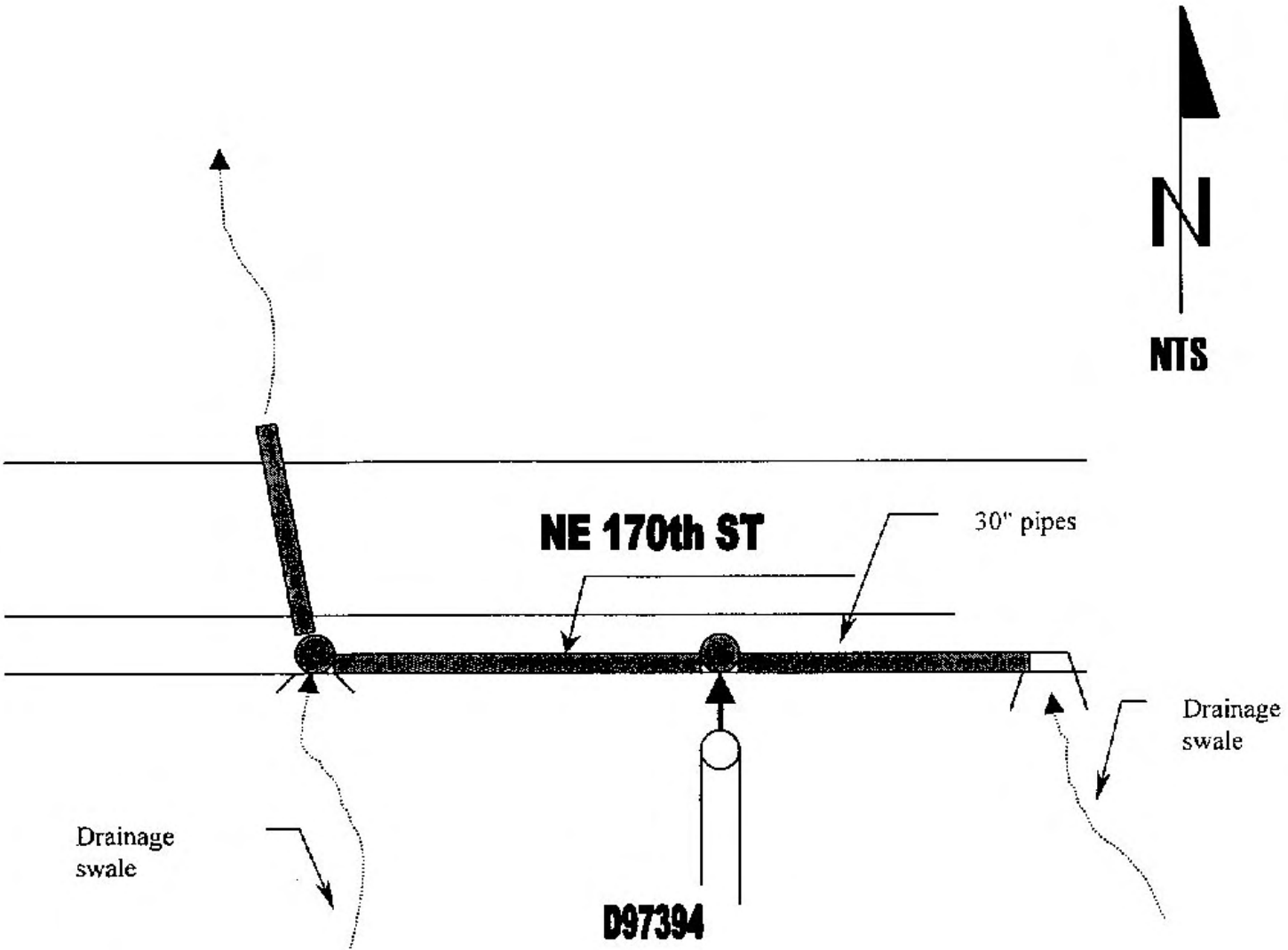
Complaint 00-00699 Meyer
Investigated by Chris Treichel 10/17/00

Met with Mr. Meyer at his residence on October 17, 2000. Mr. Meyer had questions about the rock-lined ditches on either side of his house. He lives in the new 6 lot plat of Leopold Addition within the city limits of Kenmore. His neighbor to the east of him has a back yard with a 12" pipe out letting onto the rock-lined ditch, on the north side of his residence. He wanted to know what it would take to extend the pipe and expand his yard over the ditch, as well as remove the ditch on the south side and put in pipe there. I explained that he would need to contact the city of Kenmore about a right of way use and grading permits. He was also concerned about the maintenance of the plat. I explained that the plat is still under a "punch list" (L9800474) with DDES. When they are done they will send us the plat and that we have a two year bond process. I explained the bond process and the inspections. I gave him Tim Cheatum as a contact for the punch list at DDES. I also gave him Ted Carlson's name and number for city contact. When I tried at DDES to get a copy of the plat no engineers were present. Mr. Meyer is also concerned about his neighbor maybe wanting to park a RV below his property on the access road. I explained the special use permit process to him, and that the neighbor would have to go through our office to obtain that permission.



Complaint 2001 - 0123
Investigated by Chris Treichel 02/26/01

Met with Mr. and Mrs. Romero at their residence. They were concerned because, over the weekend, there had been sediment flowing through the creek in their backyard. They had a complaint from last year under 2000-0213 for cement slurry running through the creek. There was no materials left when it was investigated and a source for the problem could not be determined. That complaint was forwarded to the Kenmore offices so their building inspector could look into any problems from up on the hill. During the field investigation the creek, was again running clear. Going up stream I found where the creek runs underneath NE 170th ST. There is a commercial facility that is east of this stream (D97394). During my assessment of this facility during the summer I found that there is a roadside drainage system that this facility enters into. The system was dry at the time and had sediment build up; it however was not a problem for the outlet from the commercial system. There is a drainage swale that runs south to north east of the commercial site. During my investigation the swale was running with water and it appears has loosened the sediment build up in the roadside system. The basin that receives the outlet from D97394 was full of water but the basin down stream where it joins with the stream had a lower flow than would be expected from a basin that full.



King County
Department of Natural Resources
Water and Land Resource Division

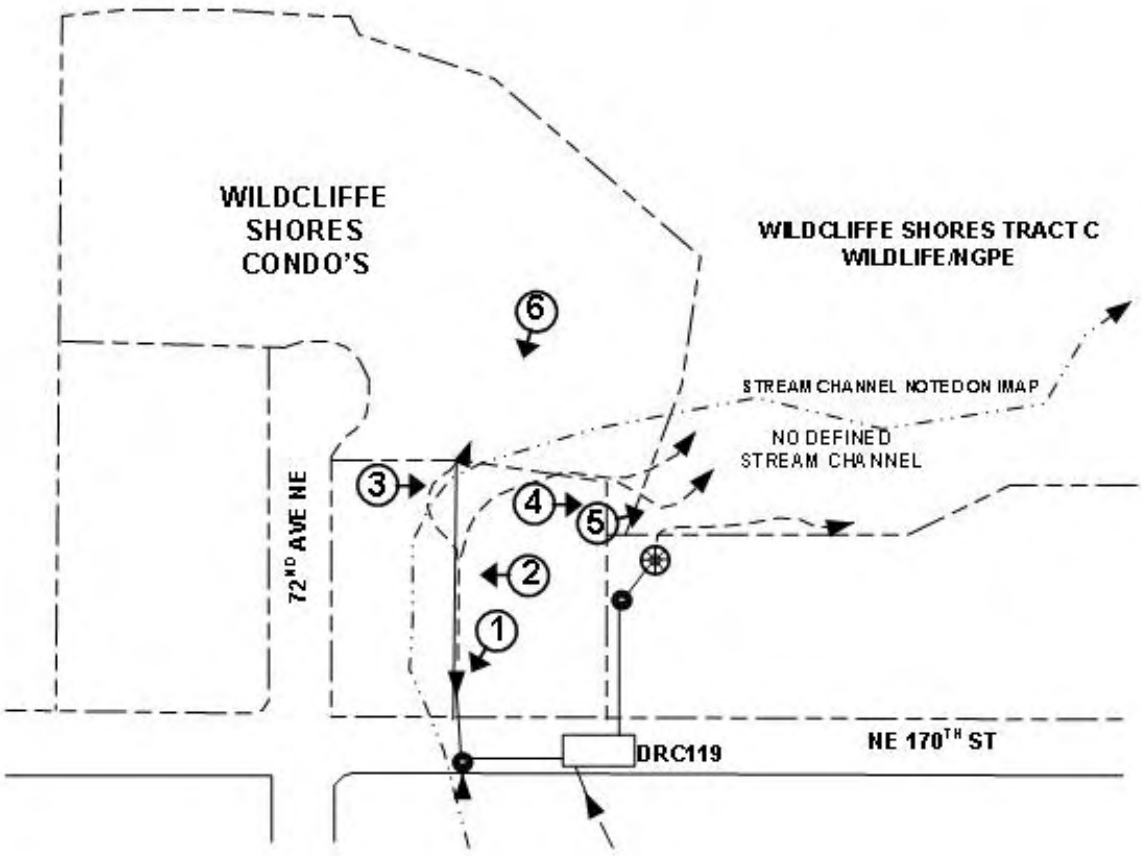
FILE NO. 09-0076 KENMORE
NAME JAY ARROYO
ADDRESS 7241 – NE 171ST LANE
PHONE 425-424-8607 TB PAGE 475-J7
KROLL PAGE 406W DATE 2-09-09
MAINT. DIVISION 1 INITIALS - MAM

DRAINAGE INVESTIGATION REPORT
FIELD INVESTIGATION

DETAILS OF INVESTIGATION:

COMPLAINT STATES: PROPERTY FLOODED DURING STORM DUE TO 4 FEET OF SILT IN STORM DRAIN CAUSING IT TO NOT CONVEY THE WATER AND OVERFLOWED STORM DRAIN.
SITE VISIT ON 1-21-09. INVESTIGATION FOUND THE PROPERTY AT 7241 – NE 171ST LANE IS A BUILDING WITHIN WILDCLIFFE SHORES CONDO'S. THE SOUTH/SOUTHEAST PORTION OF THE PROPERTY HAS A STREAM BORDERING THE PROPERTY. THE STREAM FLOWS FROM THE SOUTH AND IT APPEARS DURING THE STORM STREAM FLOWED OUTSIDE SHALLOW CHANNEL AND SPILLED OVER INTO THE CONDO'S. THERE WAS A LOT OF SEDIMENT AND GRAVEL IN THE CHANNEL. NOTICED SANDBAGS WERE PLACED ALONG THE PROPERTIES TO KEEP STREAM IN CHANNEL. NOTICED SOME TRENCHING WAS DONE TO ESTABLISH A CHANNEL AROUND THE BUILDINGS. APPEARS CHANNEL IS NOT WELL DEFINED DOWNSTREAM AND FLOWS INTO TRACT C NOTED AS A WILDLIFE/NGPE AREA. IN LOOKING AT DRAINAGE IN AREA FOUND TWO DRAINAGE CHANNELS FLOW INTO TRACT C. UNSURE AS TO THE DRAINAGE FOR THE CONDO'S HAVE IN PLACE. TALKING TO ONE OF THE OWNERS SHE STATED THEY HAVE NO DRAINAGE PLANS. IN LOOKING AT IMAP IT SHOWS STREAM FLOWING THROUGH BUILDINGS. CHANNEL MAY HAVE BEEN RESTABLISHED DURING CONSTRUCTION AND APPEARS NOT TO HAVE BEEN MAINTAINED. OTHER THEN THE STORM EVENT CAUSING CHANNEL OVERFLOW I NOTICED A VACTOR TRUCK LEAVING THE AREA. THEY MAY HAVE REMOVED SEDIMENT FROM FACILITY DRC119. THIS FACILITY HAS A LOW FLOW AND HIGH FLOW RELEASE.

PHOTO TAKEN # 1 SHOWING PIPE OUTLET TO CHANNEL.
2 SHOWING WHAT APPEARS TO BE OLD CHANNEL WHICH WAS REDIRECTED.
3 SHOWING SEDIMENT IN EXISTING CHANNEL AND PATH WATER OVERFLOWED BANK.
4 SHOWING CHANNEL DIRECTED TOWARD ORGINAL FLOW PATH.
5 SHOWING TRENCHING DONE TO DIRECT WATER TO ORIGINAL FLOW PATH.
6 SHOWING AREA AT CONDO'S WHERE WATER OVERTOPPED BANK AND ENTERED.



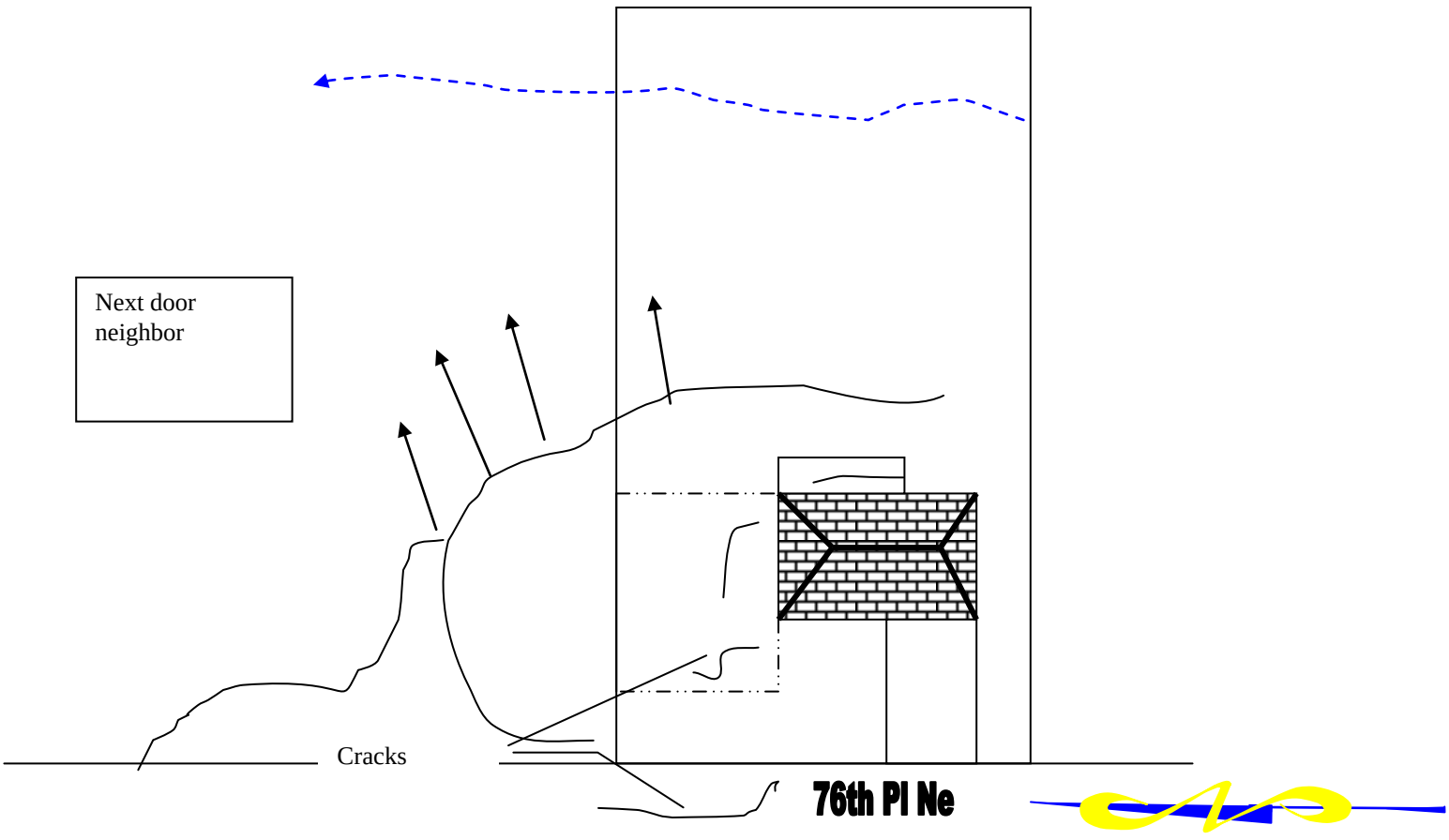
2002-0273 Beeson

King County

DRAINAGE INVESTIGATION REPORT

COMPLAINT NO: 2002-0273
LOCATION: 16034 76th Pl NE
KROLL PAGE: 411 TB PAGE: 506
SERVICE AREA: Urban (Kenmore) MD: 1
DATE: 04-11-02 INVESTIGATOR: CJT
BASIN: Sammamish River

Met with the property owners on 4-11-02. The Beeson's live at the top of steep slope that runs from west to east and south to north on their northern property line. They are concerned because the hillside shows signs of sloughing and the possibility of starting to slide. Mrs. Beeson showed me areas where there are sloughs in the yard and the back of the house. An area adjacent to the foundation, according to Mrs. Beeson, has dropped about 1 to 2 feet. There is a post that supports the deck that is starting to tilt away from the house as well. The roadway in front of the Beeson's north corner is cracked and sinking. The roadway at the crack has already dropped about 1 to 2 inches. Towards the bottom of the hillside where it starts to level out there are signs of sediments and debris being piped out of the hillside. The Beeson's downspouts discharge somewhere down hill, but I was unable to locate them. The Beeson's stated that the previous owner had told them that King County had installed a french drain in the roadway and that the possible reason that this problem is occurring is that the drain may be plugged up. There is a roadway drainage system on the west side of the road that conveys drainage down the hillside. This system appeared to be operating normally. The neighbor to the north is working on their lot and house. They did not have proper erosion control measures on the slope down to the level area, but I did not notice any holes in the hillside, as I did on the Beeson's property. I also did not notice any sloughing of the neighbors' property to the south. In speaking with Mr. Beeson he stated that the builder had to install pilings for the property during construction, he also asked me where he could obtain the inspection and building records. I told him that he could check with the city of Kenmore or King County DDES for those records.



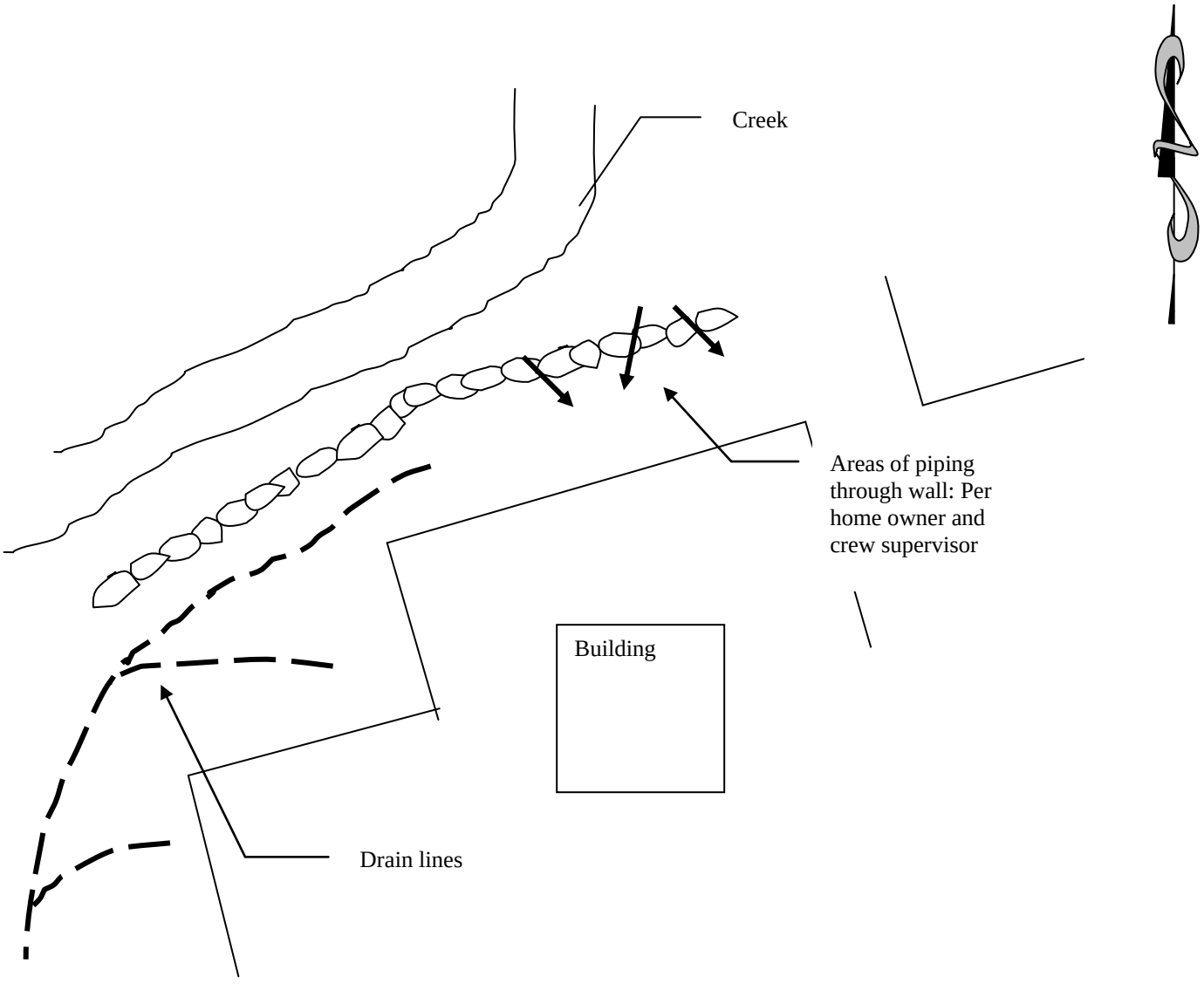
2002-0626 Zana

King County

DRAINAGE INVESTIGATION REPORT

COMPLAINT NO: 2002-0626
LOCATION: 7245 NE 171st LN
KROLL PAGE: 407 TB PAGE: 476
SERVICE AREA: Urban (Kenmore)
DATE: 9/13/02 INVESTIGATOR: CJT
BASIN: Sammamish

Visited the site and found that a company was there repairing the yard drains in the back portion of the condominiums. The site is the Wildcliffe Shores Condominiums located within the city of Kenmore. The property sits south of a large open area. The area of concern also sits lower that a portion of the creek that runs from south to north. There have been numerous complaints about this problem in the past. King County did a CIP in the area to help ease flooding. The complainant and work crew supervisor, were not at there at the time of my original visit. I received a call from the supervisor about 45 minutes later, I then returned to the site. He explained that they were replacing worn out and plugged yard drains with better pipes. He pointed out a couple of spots on the rock retaining wall between the creek and the buildings that they believe the water may be piping through. The complainant then came home and basically showed me the same items and that the association was under the impression that they were responsible to repair the wall and drainage because it was on their property. I explained that they should contact the City of Kenmore to make sure they obtain all the necessary permits needed to perform any work on the wall. The creek did appear to be impacted by sediment at the time of my visit.



KING COUNTY

DRAINAGE INVESTIGATION REPORT
FIELD INVESTIGATION

FILE NO.: 2007-0077
NAME: Ted Carlson
ADDRESS: City of Kenmore
PHONE: 425-398-8900
TH. BROS PG: 475J7
KROLL PAGE: 406
MAINT. DIV: 1
INITIALS: **NK** **Date of Complaint: 01/26/07**

Conducted site investigation on 01/26/07. I did not find any evidence of automotive oil/transmission fluid in the development or within the storm drainage conveyance system. I spoke with Mr. and Mrs. Heinrick at 7210 NE 171st Ln., 425-481-1258. They indicated that the person responsible for the pollution had cleaned it up. They explained that Mr. Steve Bangert, 425-481-0146 has been repairing a pickup truck which was parked in a nearby visitor stall. The Heinrick's explained that the development HOA has sent him a letter expressing their concerns and that follow-up meetings were planned. Mrs. Heinrick provided a copy of a neighbor's complaint letter which is attached to the file record. I left a door hanger on Mr. Bangert's residence (7237). Mr. Bangert phoned the following day and explained that he was engaged in further discussions with the HOA.

Looking southerly at the parking area in front of the Bangert residence(7237 NE 171st Ln..)

APPENDIX B

GEOENGINEERS' FIELD REPORT

GeoEngineers	**Summary Field Report**		File Number: 07457-217-00
600 Dupont Street Bellingham, WA 98225 (360) 647-1510	Project: Kenmore Sediment Study		Date: August 3-6, 2009
	Owner: City of Kenmore	Time of Arrival: Daily ~ 0800	Report Number: n/a
Prepared by: cec	Location: Sub-basin 0057	Time of Departure: Daily ~ 1700	Page:
Purpose of visit: Map sediment production mechanisms and fate	Weather: Sunny and warm to overcast and warm	Travel Time: ~1.5 hr RT	Permit Number: n/a

Upon arrival to the site I assessed personal safety hazards and reviewed hazards with the field team. Hazards included: driving to job site; surveying in remote areas; wading in streams; use of machete; walking on unstable slopes; brush (risk to eyes) and insects (bites and stings); animal burrows (tripping hazard). Control measures included: appropriate clothing, gloves, and footwear; first aid kit; drinking water; cell phones; working as a team.

PROCEDURE

Survey team included C. Cooper and M. Troost (GeoEngineers), and E. Backholm (Gray & Osborne). We surveyed major drainages and portions of tributaries in the downstream direction from NE 155th Street to the NE 170th Street and onto the Sammamish River floodplain. We documented our observations using field notes and photographs, and linked our notes and photographs with GPS data points. We surveyed sediment source areas from side-slopes and channels, and identified processes associated with sediment recruitment, transport, and deposition. We mapped zones of sediment transport and deposition. We qualitatively surveyed channel cross-sections in representative reaches and at transition zones, and collected sediment samples from slopes, banks, channel bed, and deposition features.

SUMMARY OF OBSERVATIONS

Sediment source material was dominantly derived from the natural landscape; a minor component of sediment was derived directly from residential sources (such as failures from house, yard, or road fill material).

Sediment is derived from glacial material; dominantly from advance outwash silt and sand although overlaying till units (found mostly in upper elevations) are comprised of sediments up to small boulder size. Most of the larger gravels, cobbles and boulders in the channels appear to be lag material not readily mobilized by most discharges. However, medium gravels and finer size sediments do get transported to the lowest reaches of the basin. Principal sediment production processes include lateral and vertical channel scour, and mass wasting on hillslopes – particularly due to saturation of shallow and deep permeable sand overlying an impermeable clay boundary. Animal burrows represent a substantial sediment source in some areas. Due to geology and topography, relatively high rates of sedimentation will likely persist over many decades to come unless runoff can be managed to mimic a pre-development hydrologic regimen.

Nearly all the land in the sub-basins is privately owned. Several areas within the sub-basin upstream of NE 170th Street may provide management opportunities to trap sediment. Other conceptual considerations for sediment management would include routing sediment transport flows through a box culvert under NE 170th Street onto the Sammamish River floodplain.

X **THIS FIELD REPORT IS PRELIMINARY** A preliminary report is provided solely as evidence that field observation was performed. Observations and/or conclusions and/or recommendations conveyed in the final report may vary from and shall take precedence over those indicated in a preliminary report.	**FIELD REPRESENTATIVE** C Cooper	**DATE** Aug 7, 2009
O **THIS FIELD REPORT IS FINAL** A final report is an instrument of professional service. Any conclusions drawn from this report should be discussed with and evaluated by the professional involved.	**REVIEWED BY**	**DATE**

Attachments:

Distribution:

APPENDIX C

GEOENGINEERS' SEDIMENT AND STORMWATER ASSESSMENT

DRAFT REPORT
SEDIMENT AND STORMWATER ASSESSMENT
TRIBUTARY 0057C
SAMMAMISH RIVER WATERSHED
KENMORE, WASHINGTON

DECEMBER 1, 2009

FOR
GRAY & OSBORNE, INC.

Draft Report
Sediment and Stormwater Assessment
Tributary 0057C, Sammamish River Watershed
Kenmore, Washington
File No. 7457-217-00

December 1, 2009

Prepared for:

Gray & Osborne, Inc.
701 Dexter Avenue North, Suite 200
Seattle, Washington 98109

Attention: Barry Baker, PE

Prepared by:
GeoEngineers, Inc.
600 Dupont Street
Bellingham, Washington 98225
(360) 647-1510

Craig Cooper, LG
Senior Scientist

John T. Monahan
Project Manager

Marcelle Lynde
Associate In Charge

Mary Ann Reinhart, LG, LEG
Associate

CC:ML:lw
W:\Bellingham\Projects\7\7457217\00\Working\Reporting\Draft\00745721700_DR_for final review ML.docx

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DRAFT REPORT
SEDIMENT AND STORMWATER ASSESSMENT
TRIBUTARY 0057C, SAMMAMISH RIVER WATERSHED
KENMORE, WASHINGTON
FOR
GRAY & OSBORNE, INC.

INTRODUCTION

GeoEngineers, Inc (GeoEngineers) was contracted by Gray & Osborne, Inc. (Gray & Osborne) to provide geomorphic and mapping services for a multidisciplinary project focused on sediment management of stormwater facilities in the City of Kenmore (City) within King County, Washington. The goal of this study is to provide the City with sufficient information to develop design documents for construction in 2010 of preferred alternatives for sediment control.

This report documents the findings and recommendations from our geomorphic characterization and assessment of basin and reach-scale processes influencing recruitment, transport, and deposition of sediment that affects the City's stormwater facilities management.

The project area encompasses a small basin drained by an un-named tributary, referred to as Tributary 0057C, which flows north to the Sammamish River. The project area is located in Section 13, Township 26 North, Range 4 East Willamette Meridian, and is approximately bounded within the area east of Juanita Drive, north of 150th Street, west of 84th Avenue NE, and south of the Sammamish River (Figure 1, Vicinity and Site Map).

PROJECT BACKGROUND AND UNDERSTANDING

Chronic sediment maintenance problems affect management of the City's surface water conveyance system in the basin drained by Tributary 0057C. Two culverts (stream crossings) are located at NE 163rd Street near 76th Avenue NE and at 74th Avenue NE near NE 165th Street. These culverts overtop during heavy storm events, have been eroded around the outfall and caused road shoulder failure, or have had excessive sediment build-up at their inverts or outlets. Sediment is removed under an annual programmatic HPA. Sediment is also removed annually under a programmatic HPA at the sediment trap (vault) located in NE 170th Street near 72nd Avenue NE. The vault, completed by King County in 1998 prior to the City's incorporation, has a capacity of about 50 cubic yards (yd^3). This vault appears to lack the capacity to effectively manage the sediment load it receives. In some years the vault requires multiple cleanings. The vault and associated cross culverts are overtopped during large storm events, causing roads to be temporarily closed and causing flooding and sedimentation into neighboring streets, driveways, and yards.

This history of sediment management issues prompted the City to investigate information on the sources, quantity, and management options for sediment control to maintain street and surface water systems effectively.

PROJECT OBJECTIVES AND WORK SCOPE

GeoEngineers' primary objectives for this study was to conduct a geomorphic assessment of sediment source and transport processes within the Tributary 0057C basin, and to provide a semi-quantitative approximation of sediment volumes delivered annually to the sediment trap. GeoEngineers performed the following services:

1. Identified basin and reach scale processes controlling or influencing local bank and streambed erosion and sediment deposition, and assessed the interaction between channel process and culvert conditions.
2. Qualitatively estimated annual sediment volumes arriving at the sediment trap.
3. Described treatment options for sediment management within the basin.
4. Developed presentation maps to be shared with the City.

METHODS

LITERATURE REVIEW AND INFORMATION SYNTHESIS

A kickoff meeting and preliminary site visit was conducted on June 18, 2009 with City, Gray & Osborne, and GeoEngineers staff to discuss project details. Meeting participants visited selected sites along the channel at road crossings in the lower portions of the drainage, and also visited the channel diversion about 500 feet upstream of the sediment vault at NE 170th Street as well as the vault and culvert and their outfalls north of NE 170th Street.

GeoEngineers compiled and reviewed available information pertinent to drainage-scale channel conditions. This information included digitized aerial photographs dated 2007, recent LiDAR (2005), geologic maps, topographic maps, critical areas hazards maps, and record drawings for the sediment vault, its outlet weir, and energy dissipater structure. A GIS platform was used to project and display much of the available information. These data were used to delineate stream reaches for a full field reconnaissance and subsequent geomorphic evaluation. LiDAR and aerial photos were analyzed for geographic and topographic features indicative of sediment source and deposition areas.

SEDIMENT SOURCE, TRANSPORT, FATE SURVEYS, MAPPING AND MODELING

GeoEngineers conducted reconnaissance-level field surveys on each of the two major channels within the basin from August 3 – 6, 2009. The reconnaissance focused on identifying and mapping sediment source areas; documenting sediment recruitment and transport within the channels; and assessing conditions controlling sediment deposition and channel/culvert interactions. GeoEngineers used an open-reel fiberglass measuring tape and hand level to measure gross channel cross-sections and gradients in representative channel reaches. Bulk sediment samples were also collected from channel bank and hillslope erosion scars, and point count methods were used to characterize the composition of sediment on the channel bed. Data were analyzed for incorporation into reports, maps, and presentation materials.

MAP AND REPORT PRODUCTION

GeoEngineers developed presentation materials, and together with Gray & Osborne met with City staff on September 16, 2009 to discuss preliminary findings and discuss possible remediation measures. GeoEngineers also attended a public open house hosted by the City on November 5, 2009 to share preliminary findings and address questions, concerns, and information.

BASIN SETTING

LOCATION AND TOPOGRAPHY

The project basin is situated within the Lower Sammamish River Valley sub-basin of the Sammamish River Watershed. Topography comprising the basin is generally of low relief, with an elevation difference of approximately 450 feet. Two primary stream channels of just over two miles in length drain the basin, which has an area of approximately 285 acres. Tributary 0057C and an unnamed tributary

(Trib-1) flow north and converge near the lower third of the basin. Tributary 0057C flows through a wetland complex, draining into the Sammamish River, which then discharges into Lake Washington (Figure 1).

The terrain comprising the basin can be generally characterized by four topographic sections. These sections include an upper basin area defined by low relief and low channel gradients, a steeply inclined section that contains deeply incised ravines, a lower basin area defined by moderate relief and moderate to high channel gradients, and the low gradient Sammamish River floodplain area.

GEOLOGIC HISTORY

The project basin lies within the Puget Sound Basin situated between the Cascade Range and the Olympic Mountains. The Puget Sound Basin was largely influenced and shaped by Pleistocene Continental Glaciations. The last major incursion of continental ice, the Vashon Stade of the Frasier Glaciation, is reflected in the geology of the drainage. Geologic maps (Minard, 1983; Galster and Laprade, 1991) identify the main geologic units within the basin. As shown in Figure 1, Pre-Vashon transitional beds (unit Qtb) comprised of interbedded clay, silt, and sand, underlie Vashon advance continental outwash (unit Qva), which is a thick section of well-sorted and well-stratified coarsening upwards clay, silt, sand and gravel. Stratigraphically overlaying the advance outwash is Vashon till (unit Qvt), which is a very stiff and generally impermeable unit, composed of non-sorted non-stratified clays, silts, sands, gravels, and minor boulders. This unit, which covers the upper plateau at the top of the ravines, was deposited and compacted by the glacial ice-sheet as it overrode the underlying glacial units. Recent (Holocene age) alluvium (unit Qa) is mapped in the Sammamish River floodplain. Figure 1 shows the boundaries of the geologic units described above as generally represented by Minard (1983).

Our field observations generally concurred with the mapped geologic unit boundaries. Alluvium deposited by the Sammamish River and Tributary 0057C was observed in the northern lower portion of the drainage basin where the topography is relatively flat. Transitional beds were observed in the lower middle portion of the drainage basin. Advance outwash was observed in the middle and upper middle portion of the drainage basin, but fingered further uphill (south) a considerable distance near NE 155th St than shown on the geologic map of Minard (1983). Till was observed in the upper portions of the basin.

The advance outwash is of particular importance because of the spatial relation between two distinct subunits within the outwash; the Esperance Sand and the Lawton Clay. The Esperance Sand is a highly permeable unit of clean, well-sorted sand that overlies the impermeable Lawton Clay. Water infiltrating and saturating the sand can destabilize the subunit in two ways. First, water saturation of the interstitial pores between sand grains reduces friction between the sand grains. Second, as water infiltrates the sand it trickles down to the sand-clay boundary where it then flows along the top of the relatively impermeable clay to a point of discharge. This process poses a significant potential for slope failure along the sand-clay boundary. The presence of this unit also correlated with areas mapped as landslide hazard areas (City of Kenmore, 2001, amended). During our field reconnaissance, we noted that the boundary between the sand and clay subunits most often occurred along the lower portion of the valley walls and comprised the stream banks to within several hundred feet north of NE 155th St.

LAND USE AND HYDROLOGY

The project basin has been largely developed for residential use. Development in the Upper Middle Reach of Tributary 0057C and Middle Reach of Trib-1 is restricted to ridge tops. Undeveloped portions of the parcels within the steep valley segments of the upper and middle reaches are dominantly vegetated with native second growth conifer, deciduous tree species, and brush. Nearly all ownerships in the

surveyed reaches are privately held parcels, primarily single family with some vacant lots. Zoning is R-4 and R-6 (residential with 4 or 6 units per acre) (City of Kenmore, 2001, amended).

Urbanization of any basin typically alters its hydrologic regime by increasing runoff from impervious surfaces and through direct input from catch basins that drain the surrounding residential areas. Systems typically respond with "flashier" flow, having higher volumes of flow within shorter periods of time. This response can cause an increase in stream bank and/or valley wall erosion and may ultimately increase sediment production to the system. Local geology can exacerbate this response. For example, we observed numerous groundwater seeps issuing from the sandy advance outwash (unit Qva) in the steep upper reaches, particularly from the left (east aspect) slopes in Trib-1.

Hydrology was developed for the basin by Gray & Osborne using the Western Washington Hydrology Model (WWHM3). Peak flows ranged from 26 cubic feet per second (cfs) for the 2-year recurrence interval to 56 cfs for the 100-year recurrence interval. Table 1 summarizes results from Gray & Osborne's Hydrologic Analysis.

Table 1: Recurrence Interval Discharges

Recurrence Interval	Discharge (cfs)
2 year	26
5 year	34
10 year	39
25 year	46
50 year	51
100 year	56

The area receives approximately 38 inches of rain annually (USGS 2008). Precipitation within a 24 hour period ranges between 1.6 and 1.7 inches for the 2-year 24-hour storm event, and about 3.5 inches for the 100-year 24-hour storm event (King County 2009).

PROJECT AREA CONDITIONS

INTRODUCTION

GeoEngineers conducted a qualitative geomorphic reconnaissance of approximately 1.7 miles of stream channel within the drainage basin (refer to Figure 1 and Figure 2 throughout the following reach descriptions). Our reconnaissance covered the two major drainage channels (Tributary 0057C and Trib-1) from just south of NE 155th Street to the drainage outlet just north of NE 170th Street. Field observations were aided by geologic maps, topographic hill-shade generated from 2005 LiDAR information, GPS, and 2007 aerial photography (although vegetation cover obscured from view the trace of the channels on aerial photographs). The following paragraphs describe observed channel conditions organized by reach from upstream to downstream. Reaches are generally distinguished by differences in valley geometry, channel gradient, observed sediment production and delivery mechanisms, and bank and streambed conditions.

GEOMORPHIC CHARACTERIZATION

Upper Reaches

The upper segments in each stream extend from their headwater areas north to NE 155th Street where the streams are directed under the road through culverts. The upper reaches of both channels have relatively low gradients of 1 percent or less.

Topography in the upper reaches is very low relief and channel gradients are shallow (less than 1 percent on average). Residential development in the upper reaches likely limits lateral incision, and vertical incision is controlled by culvert inverts. Trib-1 channel is shallow – less than a foot to its bankfull depth – and the minor amount of gravel-sized sediment on the streambed did not appear to be frequently mobilized, based on its dull coloration and embeddedness. Most of the observed channel bed in Trib-1 was composed of till and did not exhibit effects from stream scour. The Tributary 0057C channel was not well defined upstream of the culvert invert at NE 155th Street; it resembled more of a grassy swale. Evidence suggests negligible erosion and sediment delivery to reaches downstream. Based on our field observations, the upper reaches were not included in the field reconnaissance as they were not considered a significant source of sediment.

Tributary 0057C

Upper Middle Reach

The Upper Middle Reach of Tributary 0057C overall is characterized by a confined channel incised within a narrow, steep walled, v-shaped valley with a steep gradient. The valley gradient and the channel gradient in this reach are both approximately 12 percent. The valley bottom matches the channel width in most places and ranges from 4 feet to 10 feet. Review of LiDAR indicates valley walls rise 30 to 80 feet from the valley floor. Valley walls are commonly steep; a slope analysis completed using LiDAR revealed slopes greater than 50 percent along a major portion of the valley. Valley walls are mapped as till (unit Qvt as shown in Figure 1). However, advance outwash (unit Qva) was observed in the lower portions of the valley walls throughout the majority of the reach beginning about 400 feet downstream of the 18-inch culvert outfall at NE 155th Street.

A wide range of erosional processes and levels of severity occur within the reach, with distinct differences associated with geologic materials. The channel was vertically incised in till from the culvert outfall at NE 155th Street downstream approximately 400 feet. Till was exposed on the stream bed. The outfall is perched about 3.5 feet above the channel bed, and scour from the outfall has created a bowl-shaped depression about 8 feet wide. There was no evidence of slope failure from the upper till banks.

Channel cross-sectional geometry changed somewhat with the transition from till to sandy advance outwash. Valley width increased slightly as did the channel bottom width. Channel sidewalls were less stable and slope failures at the sandy outwash and clay boundary were observed. Minor amounts of coarse sediment were retained in the channel, and the sediment typically was trapped by woody debris.

About midway through this reach the valley opened considerably. The stream in this section is piped beneath a private driveway through a 24-inch culvert 200 feet long off of 76th Place NE. Based on LiDAR review, the culvert appears to drop approximately 35 feet in elevation from invert to outfall. Very little sediment was stored directly upstream of this culvert, suggesting the majority of sediment delivered to the channel upstream of the culvert had been transported through the culvert and farther downstream. Downstream of the culvert the valley narrows and confines the channel, but with a slightly wider stream bottom on average and slightly more in-channel storage than the portion of the reach upstream of the culvert.

Observations suggest overall that within this reach moderate sediment production occurs from slope failure, and relatively little sediment production is produced by lateral and vertical stream incision. The majority of the sediment delivered to the channel is transported out of the reach, as evidenced by relatively small volumes of observed in-channel sediment storage.

Lower Middle Reach

The Lower Middle Reach of Tributary 0057C is characterized by an approximately 4 percent gradient. As shown in Figure 1, upon its emergence from the Upper Middle Reach ravine near 162nd Court, the valley floor broadens to over 250 feet. Roughly 1000 feet downstream of the ravine near the confluence of Trib-1 downstream of 76th Avenue NE the valley narrows again. In this broader area much of the channel is connected with a broad, well-vegetated flood terrace. Downstream of confluence of the two tributaries near 74th Avenue NE the valley opens again to the Sammamish River floodplain. Within this narrowed reach segment, residential development has confined the channel. Approximately 500 feet downstream of 74th Avenue NE the stream flows through a 100-foot length of 30-inch corrugated metal pipe that is mostly below grade. Approximately 500 feet upstream of NE 170th Street the stream is split into two channels by a concrete diversion structure built by a landowner prior to 1995 (R.W. Beck 1995). The main (eastern) channel flows to the vault at NE 170th Street through an 8-foot deep ditch constructed through till. The smaller western channel, which was the main channel prior to construction of the diversion, flows through several constructed fish ponds to a separate culvert crossing at NE 170th Street approximately 100 feet west of the vault.

This reach consists of alternating areas of in-channel deposition and vertical channel incision. In-channel deposition is located in short channel segments upstream of culverts. Vertical channel incision is occurring in areas underlain by cohesive soils upstream of 76th Avenue NE. It also occurs downstream of 76th Avenue below culvert outfalls and downstream of the diversion structure in the main channel segment upstream of NE 170th Street.

A broad area is available to overbank deposition in the undeveloped area upstream of 76th Avenue NE. While the average channel gradient is 4 percent (Figure 2), the wide, well-vegetated flood-prone area accommodates over-bank flow and stores sediment.

Sediment production is lower in this reach than in the Upper Middle Reach. Few slope failures were observed in this reach. Lateral and vertical channel incision are more common, but typically were not severe. Overall, this reach has the capacity to transport its sediment load. Sediments stored within the channel and on the banks consist mostly of fine to coarse sand, with lesser amounts of gravel-size material.

Lower Reach

The Lower Reach extends from NE 170th Street down to the Sammamish River floodplain. This reach is characterized by low channel gradients and significant sediment deposits. Throughout this reach channel gradients are generally less than 1.5 percent. Main channel flow is carried from the vault roughly 200 feet through pipes to an outfall with a 60-inch diameter energy dissipation structure. Downstream of the dissipation structure the stream enters a floodplain/wetland area where the channel is poorly defined, likely in response to low gradients and sediment deposition. Channel bed sediments consist of sand and small gravel.

The smaller western channel, downstream of NE 170th Street, extends through residential yards and has been severely modified. The modifications include a constructed berm that directs flow to the east as the channel passes between the Wildcliffe Shores condominiums to the north and the residences to the south. In this area, the elevation of the channel bed is higher than the finished floor elevation of the southeasterly

condominium units (Gray & Osborne, 2009). Field evidence and review of background information (R.W. Beck, 1995) indicate that this channel segment is prone to streambed aggradation from long-term sediment deposition.

Trib-1

Middle Reach

Similar to the Upper Middle Reach of Tributary 0057C, the Middle Reach of Trib-1 is characterized by a narrow, steep walled, v-shaped valley with a steep gradient. Valley grade and stream gradient is approximately 12 percent, and the valley bottom width matches the channel width in most areas. Valley walls rise 25 to 90 feet from the valley floor with steep slopes in excess of 70 percent. Most of the reach is mapped as till (unit Qvt as shown in Figure 1); however, advance outwash (unit Qva) was observed in the lower portions of the valley walls near the channel interface throughout the majority of the reach beginning about 250 feet downstream of the 24-inch culvert outfall at NE 155th Street. Cross-sectional channel form is generally narrow and vertical-walled in till and silty clay soils, and more trapezoidal within the generally loosely consolidated sandy composition of the advance outwash. Channel bed material varied from hard till or clay to coarse sediment.

This reach is severely eroded along most of its length. Dominant erosional processes in this reach correlate well with geologic units observed in the field. No hillslope failures were observed within the 250-foot length of the reach through the till unit. From 250 feet downstream of NE 155th Street to the end of the reach at NE 163rd Street, and consistent with our observations of the advance outwash (unit Qva), we identified 27 active, recent, and older mass wasting scars of variable sizes. Mass wasting includes shallow and deep-seated translational slips, rotational slumps (which have concave slip planes), and slow to rapid earthflows. We observed numerous groundwater seeps in the reach, particularly near the base of the left (east facing) bank. Although pockets of mostly coarse sediment are present within the reach, the channel bed was largely scoured of loose sediment. A relatively large accumulation of sediment is present just upstream of the 163rd Street culvert, at the downstream end of the reach. This sediment deposit is likely a result of a backwater condition created by the culvert.

Lower Reach

The Lower Reach of Trib-1 is gentler in slope (about 7 percent channel gradient) and less confined by valley walls than the Middle Reach. This reach begins at a point where the creek exits the confined valley of the Trib-1 Middle Reach at 163rd Street and emerges into the wider portion of the Lower Middle Reach of Tributary 0057C (Figure 1). The channel is well incised and confined between a hillslope and residential development. The channel follows the left (west) side of the valley to its confluence with Tributary 0057C. At its confluence with Tributary 0057C the channel has incised downward through a tongue of fine-grained sediment that is vegetated with wild grass and ferns. This reach appears to produce only minor amounts of sediment.

SUMMARY

A wide variety of channel and hillslope erosional processes occur throughout the drainages in the basin. However, the dominant mechanism delivering sediment to the channels is slope failure along the slope/channel interface. Slope failures occur almost exclusively within the steep ravines of both tributary channels, and especially within the Middle Reach of Trib-1. The geomorphic character of the steep ravines indicates the failures are natural events that have been active for many decades prior to development.

Evidence suggests that most of the sediment delivered to the channels is episodically transported to and through the Lower Middle Reach of Tributary 0057C. Relatively little sediment storage was observed

throughout the drainage during our reconnaissance. The largest accumulations of sediment were stored upstream of road crossings in this Lower Middle Reach, likely deposited in backwater conditions due to inadequate capacity of culverts to convey discharge, or to possible culvert obstructions, or both.

Channel gradient decreases substantially in the Lower Reach downstream of NE 170th Street, inducing sediment deposition and channel aggradation. Sediments deposited in the lower reach are typically gravel-sized and smaller; the majority being fine- to coarse-sized sand.

ASSESSMENT OF SEDIMENT VOLUMES

OBJECTIVE

The objective of this assessment is to approximate the average annual sediment volume supplied to the sediment vault near the drainage outlet. The approximation of annual sediment volumes will be used in development of conceptual mitigation alternatives. Data from our field reconnaissance and available sediment vault maintenance records were utilized for this assessment.

The following sub-sections present our approach and assumptions, estimated sediment production, and our approximation of sediment volumes delivered annually to the vault near the drainage outlet.

APPROACH AND ASSUMPTIONS

Our approach included several steps: estimate volumes of sediment supplied to each channel reach, and assess the mobility of the supplied sediment by characterizing source sediment sizes and sediment size distributions through downstream channel reaches based on the hydraulic parameters of the channels. A range of average annual sediment volumes delivered to the sediment vault at NE 170th Street was approximated from sediment vault maintenance records. Details of our approach and assumptions for these elements are provided below.

Sediment Supply

During our field reconnaissance we identified discrete hillslope features, mapped their location, calculated the total sediment volume generated by the feature, and estimated its rate of sediment delivery to the channel. Rates of sediment delivery were based on the feature's approximated age and proximity to the channel. In nearly all cases, sediment was supplied directly from hillslopes to the channel by mass wasting. Ages of hillslope failures were based presence of live vegetation and their estimated ages (in years). Volumes of sediment delivered to the channel were estimated in the field from average length, width, and depth dimensions of the cavity left by the failure. We assumed that the calculated volume of sediment represented by the failure cavity was delivered to the channel in a single event.

Based on observations of streamed and bank erosion the volume of sediment contributed to the channel appears to be negligible compared to the volume of sediment produced by mass wasting events.

Sediment Mobility

Sediment mobility, as a component of sediment transport, estimates discharges (velocity of flow) required to move sediment particles of various sizes. This analysis requires comparison of the magnitude of fluid force acting on the sediment particle with the resisting force of the particle.

To complete our analysis, gross channel dimensions (slope, average width and depth, and bankfull width and depth) were measured in each reach. Average reach slopes were derived from LiDAR. Channel dimensions measured in each reach were averaged to obtain a single representative channel dimension for

that reach. An equal-lateral trapezoid was assumed for the cross-section geometry. Grain size data were used to assess the smallest particle size that would resist motion during a channel maintenance flow. Bulk sediment samples were collected from representative erosion failure scars, blocks, and in-channel deposits. Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS). Collection and analysis of surface sediment on the channel bed followed methodology outlined by Wolman (1954). Measurements were tabulated and particle size distributions were graphed.

RESULTS

Sediment Supply

Table 2 displays the estimated total volume of sediment delivered to channels in each reach. Note that an estimated volume for any age in a reach reflects a sum from all failures of that age. The Total Annual Volume gives a sum of the subtotal annual volumes for the combined channel systems.

Table 2: Estimated Volume Sediment Delivered to Tributary Systems by Reach and Age in Years

SYSTEM	REACH	ESTIMATED AGE IN YEARS	NUMBER OF FEATURES BY AGE OF EVENT	SUM OF VOLUMES (CUBIC YARDS)
Trib-0057C	Upper Middle Reach	1	7	48
		2 – 9	4	77
		10+	1	185
	Lower Middle Reach	1	1	24
		4	1	24
Subtotal Volume				**358**
Trib-1	Middle Reach	1	4	61
		2-9	14	305
		10+	9	808
Subtotal Volume				**1174**
Total Volume				**1532**

Note: see Appendix B data table for field approximations of sediment volumes based on average lengths, widths, and assumed depths of failure features.

Sediment Mobility

A large range of sediment grain sizes – from very fine sand to boulders (greater than 10 inches) – are supplied to the channels from source areas. Minor amounts of stored sediment were observed within the steep channels in the ravine reaches. These reaches, having gradients of about 12 percent, are sediment transport reaches. Downstream of the ravine reaches the average channel gradients decrease to 4 percent or less. We observed that more sediment was deposited in these reduced energy channels than was stored in the channels in the steep ravine reaches. Grain sizes of the sediment deposited in the reduced energy channels appeared to be smaller than 6 inches in diameter. The largest accumulations of sediment in the

lower gradient channels were located upstream of culvert inverts (likely due to insufficient culvert capacities or obstructions of their inverts). Otherwise, the channel beds exhibited a few areas of sediment accumulation in the form of bars. These observations suggest that the majority of sediment delivered to the system is transported to the sediment vault.

To test this assumption, sediment mobility calculations were completed using sediment transport relationships developed by Shields (*in* Dingman, 1984), from which the mobilization of specific sediment sizes can be assessed. In general, initial movement (incipient motion) of sediment particles is achieved by flow whenever the magnitude of instantaneous fluid force acting on the sediment particle exceeds the resistance force for the particle to be moved. As a first approximation, the two most important factors governing the movement of a sediment particle are the fluid force acting on the particle (F_1), and the resistance of the particle to be moved (F_2). The critical shear stress for incipient motion of nearly uniform-sized cohesionless sediment particles is defined as the dimensionless ratio between F_1 and F_2 and is further characterized by different researchers to lie between the values of 0.039 and 0.090 (see summary in Reid and Dunne, 1996). For example:

$$\tau^* = F_1/F_2 = K = [(Yw)(R)(S)] \div [(Ys-Yw)D]$$

where Yw and Ys are the specific weight for water and sediment respectively, R is the hydraulic radius, S is the energy slope, D is the average diameter of the sediment particle, and K reflects the degree of packing between particles.

Hydraulic radius was calculated using bankfull areas and wetted perimeters from representative cross sections within each surveyed reach. Channel dimensions were averaged, and an equal-lateral trapezoid was assumed for the cross-sectional geometry. Average reach slope values determined from LiDAR were used for the energy slope. The use of LiDAR-generated gradients typically results in larger calculated shear stresses because topographic slope gradients are typically greater than modeled values of hydraulic energy slope. However, in the absence of more precise survey, average gradients derived from LiDAR provide an acceptable first approximation. To offset the possible exaggeration of slope values, we selected K-values of 0.04 to reflect a conservative estimate. Tightly packed particles (less mobile) have K values near 0.09, and loosely packed particles (more mobile) have K values close to 0.04. The equation was solved for D for the representative channel cross section in each reach.

Results are summarized in Table 3. The smallest particle diameter in the system that would resist motion was calculated at approximately 5 inches. We assumed everything smaller than 5 inches could be moved at bankfull discharge (approximately the 2-year recurrence interval flow, or 26 cfs (Table 1).

Table 3: Insipient Motion Calculations Solved for D

Creek	Reach	D(ft)	D(inch)	D(mm)
Tributary 0057C	Upper Middle	1.11	13.36	339
	Lower Middle	0.42	5.00	126
Trib-1	Middle	1.08	12.90	327
	Lower	0.60	7.20	183

Grain size distributions from bulk sampling of hillslope failure scars and in-channel deposits are displayed in Figure 3. The D_{100} of all bulk samples was less than 3 inches. The D_{100} of the surface layer (Wolman pebble count) was about 6 inches (large cobble). Size distributions of surface particles from a Wolman pebble count is displayed in Figure 4.

Results of the sediment mobility analysis indicate that a large percentage of sediment volumes contributed from source areas can be transported downstream to the sediment vault at bankfull conditions, or the 2-year interval flow. This result is consistent with our field observations. Average sediment sizes observed in the channel (D_{100}) are smaller than the minimum D values (5 inches) determined from the sediment mobility analysis.

Vault Maintenance Records

Both King County and the City maintain the sediment vault on NE 170th Street. The City contracts a private firm for sediment extraction. Requests were made to each of these entities for frequency and quantities of sediment removed from the vault. Table 4 shows estimated quantities and approximate dates of sediment removal provided from the request.

Table 4: Approximate Dates and Sediment Quantities Removed from Vault

Date (mo-yr)	Approximate Quantity (yd^3)		Total Quantity (yd^3)
	King County	City of Kenmore	
Apr-2001	24	-	24
Sep-2002	30	-	30
Sep-2003	22	-	22
2004	0	-	0
2005	0	-	0
Oct Nov- 2006	0	50	50
Sep Oct Nov-2007	40	50	90
Sep Oct Nov-2008	33	50	83
Jan Apr-2009	0	100	100

Reported quantities reflect sediment removal from the vault only and do not include extraction of in-channel or over bank sediment accumulated at the entrance (presumably due to the vault having been filled to capacity). The City's contractor reported only that the vault had been filled to capacity; therefore we assumed 50 yd^3 for each cleaning event based on the vault's estimated capacity.

SUMMARY – APPROXIMATION OF SEDIMENT VOLUMES

Our assessment of sediment mobility indicates that most sediment could be transported from the steep upper reaches to the sediment vault. In any given year transport will depend on magnitude, frequency, and duration of transporting flows. We conservatively estimated sediment mobility based on average channel dimensions. Flood flow in excess of the 2-year flow would have greater likelihood of mobilizing in-channel sediments. Peak flows up exceeding the 2-year recurrence interval flows (about 26 cfs in the basin, Table 1) have occurred over the past several years in this basin.

Reported quantities of sediment extracted from the vault represent a minimum sediment volume delivered from Tributary 0057C. Reported annual quantities are minimums because records only account for sediment volumes retained in the vault, and do not account for sediment that would have been routed to the western branch of Tributary 0057C or deposited from overbank flows due to the vault having reached capacity or that would have been routed through the vault.

Based on our field reconnaissance and assumptions, total average annual volumes from documented landslides is about 153 yd^3 (average volumes from all years, Table 2). Based on the amount of sediment removed from the vaults, we conclude that the range of annual sediment volume delivered to the sediment vault is about 0 to 100 cubic yards (Table 4).

DESCRIPTIVE TREATMENTS FOR SEDIMENT MANAGEMENT

This section presents a list of descriptive treatments that may be considered for mitigating the production, routing, and delivery of sediment to the Tributary 0057C drainage basin outlet. Treatments are listed individually, but may be combined in part or in whole.

TREATMENT A: CONTROL HYDROLOGY

Vertical or lateral channel incision is affected by hydrologic changes induced by increases in the flow. Incision of channel banks in the steep ravines exacerbates hillslope failures. In addition, surface water infiltrating the sandy outwash (unit Qva) may play a role in destabilizing slope soils at and above the clay boundary. Treatments to address these conditions include:

- Construct a flow detention facility in Trib-1 south of NE 155th Street. Relatively flat topography in the till unit on two parcels south of and adjacent to NE 155th Street may offer a site for detaining runoff from large storm events. Reduce infiltration into ravine slopes by intercepting runoff from roofs, drains, driveways, roads, and landscaped yards and routing the runoff to the stormwater system.
- Provide public outreach, education and awareness to individuals and neighborhoods regarding best management practices available for reducing water infiltration in susceptible areas.

TREATMENT B: SEDIMENT TRAPS UPSTREAM OF NE 170TH STREET

Construct in-channel and off-channel sediment traps south of NE 170th Street. Opportunities are limited by available surface area, and by ownership and easement issues. Potential site considerations in the Trib-1 channel include an in-channel trap below the culvert outfall at NE 163rd Street. Potential sediment trap locations in the Tributary 0057C channel include the following:

- The upstream side of the 24-inch culvert crossing of a private drive about 500 feet downstream of NE 155th Street. The private drive access is off of 76th Place NE.
- Within the broad valley segment about 400 feet to 1,000 feet upstream of 76th Avenue NE. This area would offer opportunities for passive sediment entrapment by placing large wood in the channel to promote over-bank flooding and deposition.
- Within a 400-foot segment of channel downstream of 76th Avenue NE. This area includes the junction of the two channels. Local topography may favor placement of log weirs near the downstream end of the segment in an existing depositional area. Trapped sediment over time could re-grade the channel upstream, through the existing incised channel segments up to the culvert outfall.
- Either side of 74th Avenue NE. This area offers opportunities for the placement of natural or structural sediment traps.
- Within an approximately 200-foot segment of channel in presently undeveloped parcels about 200 feet upstream of the flow diversion. The channel in this segment mostly flows below grade in open culverts through a swale, which may be enlarged to detain flood flow and intercept sediment.

TREATMENT C: IMPROVE SEDIMENT CONVEYANCE AT NE 170TH STREET AND CONSTRUCT A NATURAL SEDIMENT TRAP

The sediment vault does not have capacity to trap all sediment delivered to it in some years. This treatment would improve sediment conveyance past NE 170th Street by removing the existing vault and pipes beneath NE 170th Street and constructing a box culvert with capacity to convey large sediment-charged flow. Downstream of NE 170th Street construct a channel that broadens and shallows as it emerges onto the floodplain within a wide flood-prone area having a broad meander to promote coarse sediment deposition. The large, low gradient area downstream of the confluence of the western and eastern branches of the Tributary 0057C channel may be utilized as a natural sediment trap.

LIMITATIONS

GeoEngineers Inc. (GeoEngineers) was contracted by Gray & Osborne to conduct this qualitative geomorphic evaluation for Tributary 0057C, Sammamish River Watershed. This report constitutes GeoEngineers' draft deliverable product under this contract. This assessment is based on qualitative observation and information; the results should therefore be considered approximate. It must be emphasized that natural stream systems within developed areas such as Tributary 0057C are dynamic and subject to change over time.

We have prepared this report for the exclusive use of Gray & Osborne and their authorized agents. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. The information contained herein should not be applied for any purpose or project except the one originally contemplated.

This report has been prepared within the limitations of the project scope, schedule and budget. Our services have been executed in accordance with generally accepted practices in the field of fluvial geomorphology in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

REFERENCES

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APPENDIX A
FIGURES

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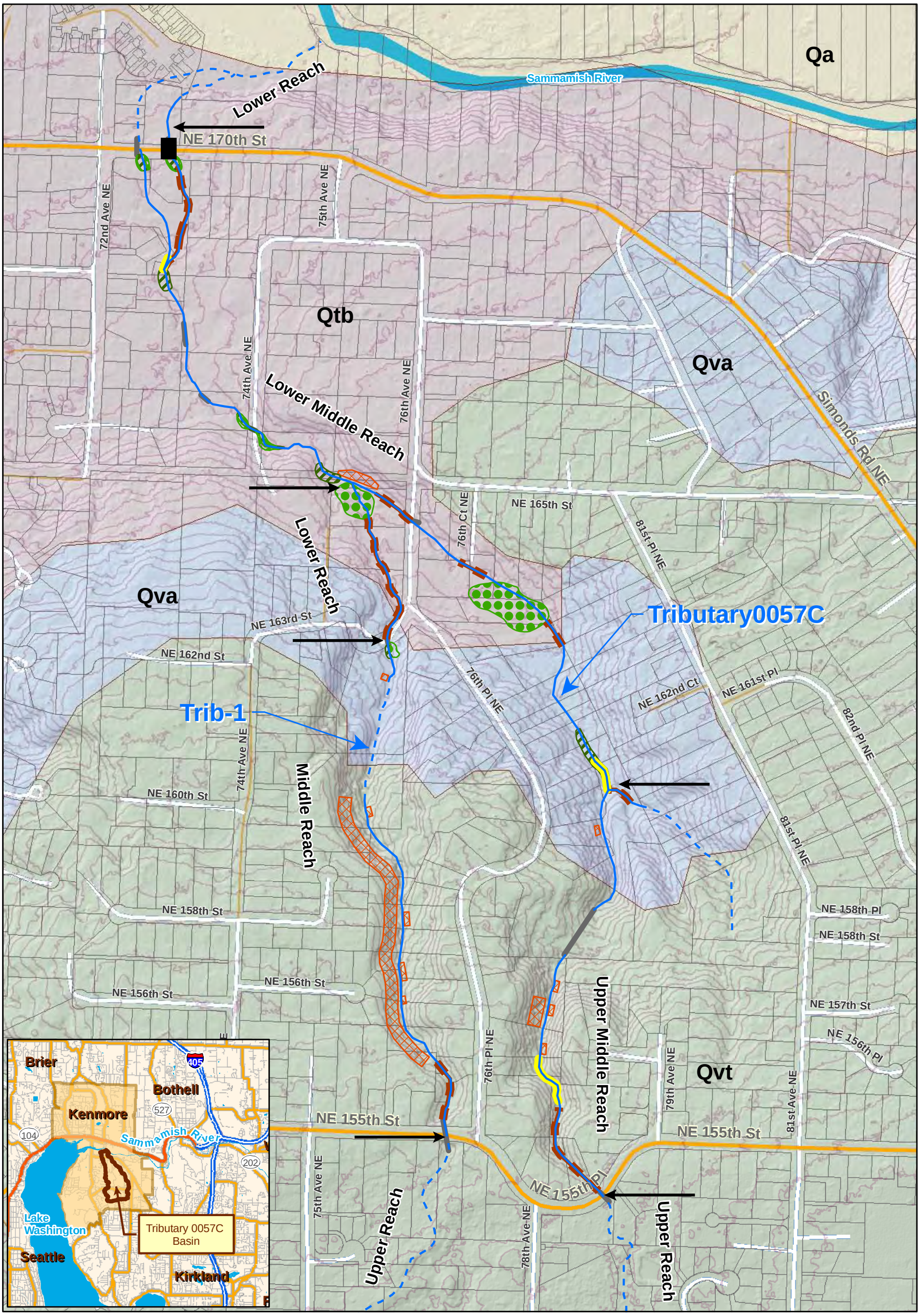

Base Information
- Parcels
- Culverts
- Sediment Trap
- 10 ft Contours
- Channel Surveyed
- Channel Not Surveyed
- Reach Breaks

Processes
- Lateral Incision
- Vertical Incision
- Deposition in Channel
- Deposition in Overbank
- Mass Wasting

Geology
- Qa - alluvium
- Qvt - continental glacial till
- Qva - advance outwash
- Qtb - transitional beds

N W E S

0 200 400 800 Feet

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

Reference: Field sketch data from GeoEngineers. Base data from ESRI and King County. Slopes and contours derived from LiDAR provided by King County. Streams Modified from King County. Data projected as NAD 83 HARN Stateplane Washington North (feet).

Vicinity and Site Map

City of Kenmore Tributary 0057C Basin Sediment Study Kenmore, WA

GeoEngineers

Figure 1

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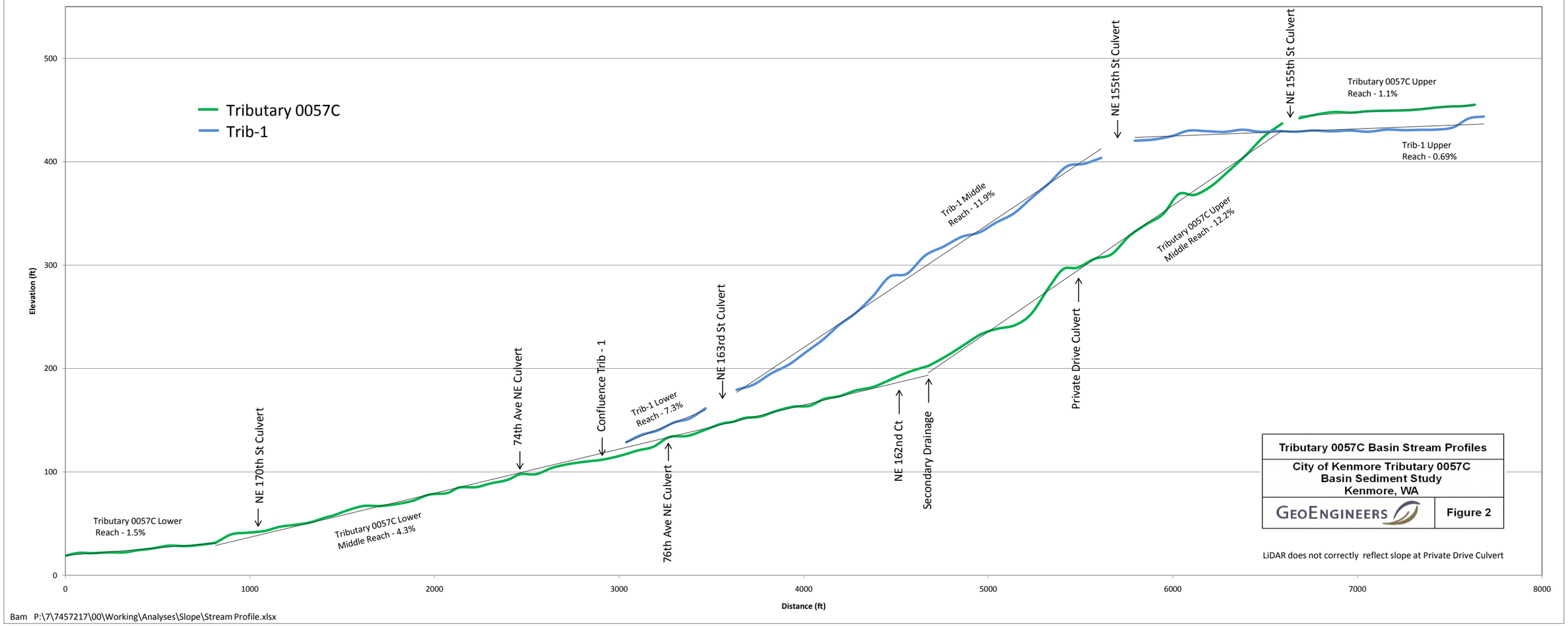
Tributary 0057C Basin Streams Profiles



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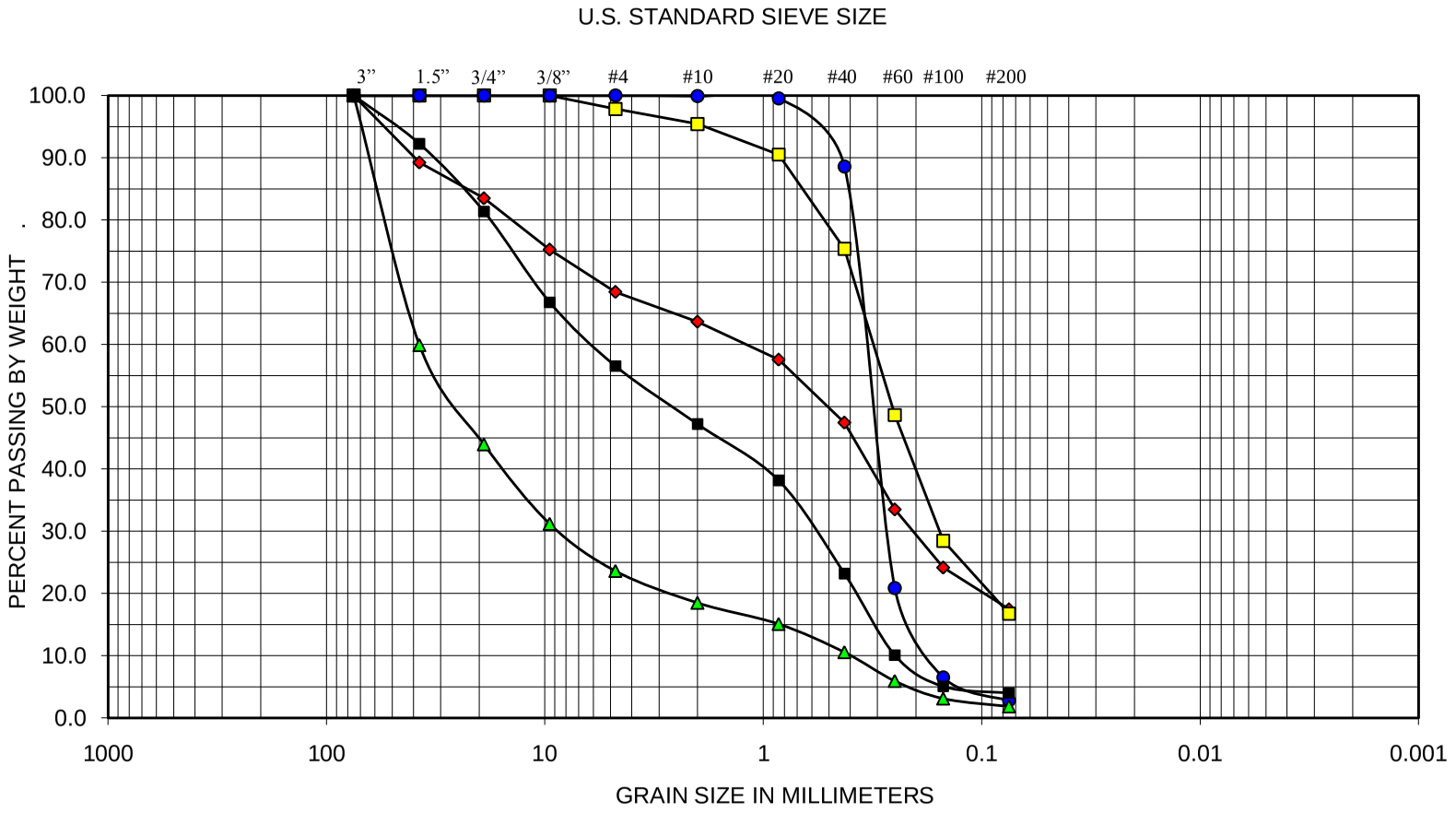
GEOENGINEERS

FIGURE 3

SIEVE ANALYSIS RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	GEOLOGIC UNIT	LOCATION: TRIBUTARY AND REACH, AND D_{50}
◆	TILL (Qvt)	TRIB-1, Middle Reach, D_{50} = 0.50
□	OUTWASH (Qva)	TRIB-1, Middle Reach, D_{50} = 0.25
●	OUTWASH (Qva)	TRIB-1, Middle Reach, D_{50} = 0.31
▲	SUBSURFACE (channel bar)	TRIBUTARY 0057C, Lower Middle Reach, D_{50} = 20.4
■	SUBSURFACE (channel bar)	TRIB-1, Middle Reach, D_{50} = 1.1

DRAFT

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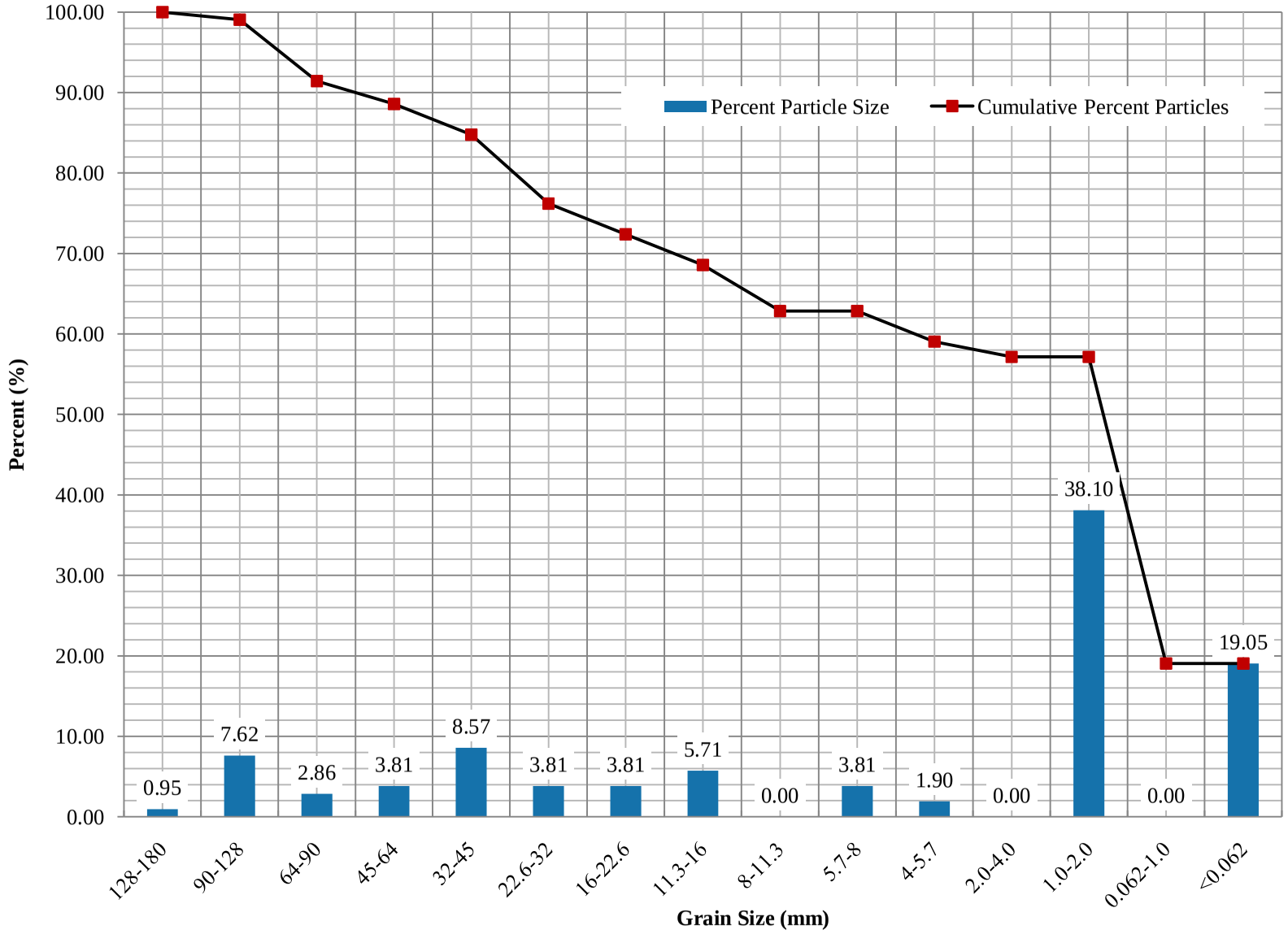
FIGURE 4

WOLMAN PEBBLE COUNT RESULTS

Cross Section Pebble Count Tributary 0057C Lower Middle Reach



DRAFT

APPENDIX B
DATA TABLE

Volume Estimates of Slope Failures Observed in Basin

GPS Data Points	Estimated Height (ft)	Estimated Length (ft)	Estimated Depth (ft)	Volume (cf)	Volume Delivered to the Channel (cy)	Estimated Age of Feature (years)
10	8.00	10.00	2.30	184.00	6.8	2
11_12	30.00	30.00	3.00	2700.00	100.0	10
11	40.00	15.00	2.50	1500.00	55.6	2
11-14	6.00	6.00	1.50	54.00	2.0	4
11-14	6.00	6.00	1.50	54.00	2.0	4
11-14	6.00	6.00	1.50	54.00	2.0	4
11-14	6.00	6.00	1.50	54.00	2.0	4
14	6.00	6.00	1.50	54.00	2.0	4
15	15.00	12.00	1.50	270.00	10.0	1
15	15.00	12.00	1.50	270.00	10.0	1
16	15.00	4.00	0.50	30.00	1.1	10
16-17	13.00	120.00	1.00	1560.00	57.8	5
15-17	8.00	10.00	1.00	80.00	3.0	10
15-17	8.00	10.00	1.00	80.00	3.0	10
15-17	8.00	10.00	1.00	80.00	3.0	10
18	8.00	14.00	4.00	448.00	16.6	10
18	12.00	12.00	2.00	288.00	10.7	10
18	4.00	30.00	1.00	120.00	4.4	20
19	30.00	18.00	6.00	3240.00	120.0	3
20	10.00	30.00	2.00	600.00	22.2	1
21-22	6.00	80.00	1.50	720.00	26.7	5
22-23	30.00	60.00	10.00	18000.00	666.7	10
24	6.00	10.00	1.00	60.00	2.2	5
24	4.00	10.00	1.00	40.00	1.5	5
24	12.00	10.00	3.00	360.00	13.3	5
12	10.00	15.00	2.00	300.00	11.1	5
33	8.00	12.00	1.00	96.00	3.6	1
33	8.00	12.00	1.00	96.00	3.6	1
33	30.00	12.00	2.00	720.00	26.7	1
34	20.00	25.00	10.00	5000.00	185.2	10
34	10.00	7.00	2.00	140.00	5.2	1
34	20.00	15.00	2.00	600.00	22.2	2
35	10.00	35.00	2.00	700.00	25.9	5
39	10.00	8.00	1.00	80.00	3.0	1
39	10.00	8.00	1.00	80.00	3.0	1
39	10.00	8.00	1.00	80.00	3.0	1
39	10.00	30.00	2.00	600.00	22.2	5
41	12.00	8.00	2.00	192.00	7.1	3
53	8.00	8.00	8.00	512.00	19.0	1
54	8.00	40.00	2.00	640.00	23.7	4
61	8.00	40.00	2.00	640.00	23.7	1
			Totals	**41376**	**1532**	

Trib-1/Middle Reach
Tributary 0057C/Upper Middle Reach
Tributary 0057C/Lower Middle Reach

APPENDIX D

PLANNING LEVEL COST ESTIMATES

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 1 - DETENTION FACILITY AT NE 155TH ST
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec. No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 22,500.00	$ 22,500.00
2	2-01.5	Clearing and Grubbing	0.11 AC	$ 7,000.00	$ 800.00
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1 LS	$ 2,000.00	$ 2,000.00
8	2-02.5	Removal of Structure and Obstructions	1 LS	$ 1,000.00	$ 1,000.00
9	1-04.12	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10		Reconnect to Existing Storm Drainage System	2 EA	$ 1,000.00	$ 2,000.00
11	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading - For Detention facility and Trench (Incl. Haul)	1,000 CY	$ 12.00	$ 12,000.00
12	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
13	7-17.3(3)	Bank Run Gravel for Trench Backfill	49 CY	$ 25.00	$ 1,222.22
14	1-09.14(1)	Unsuitable Foundation Excavation	50 CY	$ 50.00	$ 2,500.00
15		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
16	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	100 LF	$ 131.00	$ 13,100.00
17	2-02.3(4)	Sawcutting	240 LF	$ 3.00	$ 720.00
18	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	11 TN	$ 110.00	$ 1,210.00
19	4-04.5	Crushed Surfacing Base Course	15 TN	$ 35.00	$ 513.33
20	4-04.5	Crushed Surfacing Top Course	22 TN	$ 25.00	$ 550.00
21		Asphalt Treated Base	7 TN	$ 110.00	$ 806.67
22		Remove/Replace Concrete Sidewalk	6 SY	$ 50.00	$ 277.78
23	8-04	Remove/Replace Concrete Curb and Gutter	10 LF	$ 30.00	$ 300.00
24	8-22	Restore Pavement Marking	30 LF	$ 0.50	$ 15.00
25	8-02.5	Landscape Removal/Restoration	1 LS	$ 5,000.00	$ 5,000.00
26	8-02.5	Topsoil Type A	75 CY	$ 40.00	$ 3,000.00
27		Structural Shoring for Detention Vault	1 LS	$ 80,000.00	$ 80,000.00
28	6-06.5	Precast Concrete Detention Vault	1 LS	$ 100,000.00	$ 100,000.00
29		Connecting to Existing System	2 EA	$ 1,500.00	$ 3,000.00
30	7-05.5	Catch Basin Type I	1 EA	$ 2,400.00	$ 2,400.00
31	7-05.5	Catch Basin Type II	1 EA	$ 3,500.00	$ 3,500.00
32	8-02.5	Seeding, Fertilizing and Mulching	200 SY	$ 4.00	$ 800.00
33	8-15.5	Quarry Spalls	10 TN	$ 35.00	$ 350.00
34	7-08.3(1)C	Compaction Testing	1 EA	$ 12.00	$ 12.00
		Subtotal			$ 286,377.00
		Sales Tax at 8.5%			$ 24,342.05
		Subtotal, Estimated Construction Cost			$ 310,719.05
		Construction Cost Estimate			***$ 311,000.00***
		Contingency (30% of Construction Cost)			$ 93,300.00
		Easement acquisition*	8,670 SF	$ 8.80	$ 76,296.00
		Engineering, Legal and Administration			$ 77,750.00
		Construction Management			$ 46,650.00
		Permitting			$ 15,550.00
		Project Cost Estimate			**$ 621,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 2 - SEDIMENT VAULT AT PRIVATE DRIVE
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 11,300.00	$ 11,300.00
2	2-01.5	Clearing and Grubbing	0.03 AC	$ 7,000.00	$ 176.77
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
5	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
6	7-08.5	Trench Shoring and Excavation Safety	1 LS	$ 2,000.00	$ 2,000.00
7	2-02.5	Removal of Structure and Obstructions	1 LS	$ 1,000.00	$ 1,000.00
8	1-04.12	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
9	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Sediment Trap (Incl. Haul)	200 CY	$ 12.00	$ 2,400.00
10	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
11	2-03.5	Bank Run Gravel for Trench Backfill	20 CY	$ 25.00	$ 500.00
12	1-09.14(1)	Unsuitable Foundation Excavation	10 CY	$ 50.00	$ 500.00
13		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
14	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	30 LF	$ 131.00	$ 3,930.00
15	2-02.3(4)	Sawcutting	240 LF	$ 3.00	$ 720.00
16	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	11 SY	$ 110.00	$ 1,210.00
17	4-04.5	Crushed Surfacing Base Course	15 TN	$ 35.00	$ 513.33
18	4-04.5	Crushed Surfacing Top Course	22 TN	$ 25.00	$ 550.00
19		Asphalt Treated Base	7 TN	$ 110.00	$ 806.67
20		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
21		Gravel Backfill for Foundation Class B	30 TN	$ 20.00	$ 600.00
22	8-02.5	Landscape Removal/Restoration	1 LS	$ 5,000.00	$ 5,000.00
23	6-06.5	Precast Concrete Sediment Vault	1 LS	$ 82,500.00	$ 82,500.00
24	8-02.5	Seeding, Fertilizing and Mulching	100 SY	$ 4.00	$ 400.00
25	8-02.5	Topsoil Type A	10 CY	$ 40.00	$ 400.00
26	8-15.5	Quarry Spalls	10 TN	$ 35.00	$ 350.00
27	7-08.3(1)C	Compaction Testing	4 EA	$ 12.00	$ 48.00
		Subtotal			$ 143,904.77
		Sales Tax at 8.5%			$ 12,231.91
		Subtotal, Estimated Construction Cost			$ 156,136.67
		Construction Cost Estimate			***$ 157,000.00***
		Contingency (30% of Construction Cost)			$ 47,100.00
		Easement acquisition*	400 SF	$ 1.25	$ 500.00
		Engineering, Legal and Administration			$ 39,250.00
		Construction Management			$ 23,550.00
		Permitting			$ 7,850.00
		Project Cost Estimate			**$ 276,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors * 75%

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 3 - NATURAL SEDIMENT TRAP WITHIN TRIBUTARY 057
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 3,700.00	$ 3,700.00
2	2-01.5	Construction Surveying, Staking, and As-Built Drawing	1 LS	$ 5,000.00	$ 5,000.00
3	1-05.4(2)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
4	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	2-01.5	Clearing and Grubbing	0.10 AC	$ 7,000.00	$ 707.07
7	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Drainage Channel, Incl. Haul	100 CY	$ 12.00	$ 1,200.00
8	2-03.5	Unsuitable Foundation Excavation	5 CY	$ 50.00	$ 250.00
9	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10	2-12.5	Construction Geotextile for Soil Stabilization	50 SY	$ 3.00	$ 150.00
11	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
12	8-02.5	Seeding, Fertilizing and Mulching	100 SY	$ 4.00	$ 400.00
13	8-02.5	Topsoil Type A	10 CY	$ 40.00	$ 400.00
14	8-15.5	Quarry Spalls	10 TN	$ 35.00	$ 350.00
15	8-15.5	River Rock	150 TN	$ 25.00	$ 3,750.00
16	8-02.5	Stream Buffer Enhancement	200 SY	$ 20.00	$ 4,000.00
17	8-02.5	Root Wad Buttress	50 SF	$ 41.00	$ 2,050.00
18	8-02.5	Log Cross Vanes	100 LF	$ 77.00	$ 7,700.00
		Subtotal			$ 46,457.07
		Sales Tax at 8.5%			$ 3,948.85
		Subtotal, Estimated Construction Cost			$ 50,405.92
		Construction Cost Estimate			***$ 51,000.00***
		Contingency (30% of Construction Cost)			$ 15,300.00
		Easement acquisition*	400 SF	$ 1.25	$ 500.00
		Engineering, Legal and Administration			$ 12,750.00
		Construction Management			$ 7,650.00
		Permitting			$ 2,550.00
		Easement acquisition*			**$ 90,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 4 - STRUCTURAL SEDIMENT TRAP WITHIN TRIBUTARY 057
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY		UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1	LS	$ 12,300.00	$ 12,300.00
2	2-01.5	Clearing and Grubbing	0.03	AC	$ 7,000.00	$ 176.77
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1	LS	$ 5,000.00	$ 5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1	LS	$ 1,500.00	$ 1,500.00
5	8-01.5	Temporary Erosion/Water Pollution Control	1	LS	$ 1,000.00	$ 1,000.00
6	7-08.5	Trench Shoring and Excavation Safety	1	LS	$ 2,000.00	$ 2,000.00
7	2-02.5	Removal of Structure and Obstructions	1	LS	$ 1,000.00	$ 1,000.00
8	2-03.5	Temporary Bypass/Diversion	1	LS	$ 10,000.00	$ 10,000.00
9	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Sediment Trap (Incl. Haul)	1,000	CY	$ 12.00	$ 12,000.00
10	1-07.17	Locate and Protect Existing Utilities	1	LS	$ 1,500.00	$ 1,500.00
11	7-17.3(3)	Bank Run Gravel for Trench Backfill	5	CY	$ 25.00	$ 125.00
12	2-03.5	Unsuitable Foundation Excavation	50	CY	$ 50.00	$ 2,500.00
13	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	10	LF	$ 131.00	$ 1,310.00
14	8-02.5	Landscape Removal/Restoration	1	LS	$ 5,000.00	$ 5,000.00
15	6-06.5	Precast Concrete Sediment Vault	1	LS	$ 100,000.00	$ 100,000.00
16	8-02.5	Seeding, Fertilizing and Mulching	100	SY	$ 4.00	$ 400.00
17	8-15.5	Quarry Spalls	10	TN	$ 35.00	$ 350.00
18	7-08.3(1)C	Compaction Testing	1	EA	$ 12.00	$ 12.00
		Subtotal				$ 156,173.77
		Sales Tax at 8.5%				$ 13,274.77
		Subtotal, Estimated Construction Cost				$ 169,448.54
		Construction Cost Estimate				***$ 170,000.00***
		Contingency (30% of Construction Cost)				$ 51,000.00
		Easement acquisition*	800	SF	$1.00	$ 800.00
		Engineering, Legal and Administration				$ 42,500.00
		Construction Management				$ 25,500.00
		Permitting				$ 8,500.00
		Project Cost Estimate				**$ 299,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 5 - STRUCTURAL SEDIMENT TRAP AT NE 163RD ST
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 21,400.00	$ 21,400.00
2	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
3	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
4	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	2-01.5	Clearing and Grubbing	0.10 AC	$ 7,000.00	$ 707.07
7	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Drainage Channel, Incl. Haul	100 CY	$ 12.00	$ 1,200.00
8	2-03.5	Unsuitable Foundation Excavation	5 CY	$ 50.00	$ 250.00
9	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10	2-03.5	Bank Run Gravel for Trench Backfill	292 TN	$ 25.00	$ 7,298.72
11	2-12.5	Construction Geotextile for Soil Stabilization	200 SY	$ 3.00	$ 600.00
12	7-08.5	Dewatering	1 LS	$ 10,000.00	$ 10,000.00
13	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,500.00	$ 1,500.00
14	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
15		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
16	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	70 LF	$ 131.00	$ 9,170.00
17	2-02.3(4)	Sawcutting	240 LF	$ 3.00	$ 720.00
18	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	11 SY	$ 110.00	$ 1,210.00
19	4-04.5	Crushed Surfacing Base Course	15 TN	$ 35.00	$ 513.33
20	4-04.5	Crushed Surfacing Top Course	11 TN	$ 25.00	$ 275.00
21		Asphalt Treated Base	7 TN	$ 110.00	$ 806.67
22	8-02.5	Landscape Removal/Restoration	1 LS	$ 2,400.00	$ 2,400.00
23	6-06.5	Precast Concrete Sediment Vault	1 LS	$187,500.00	$ 187,500.00
		Subtotal			$ 272,850.79
		Sales Tax at 8.5%			$ 23,192.32
		Subtotal, Estimated Construction Cost			$ 296,043.11
		Construction Cost Estimate			***$ 297,000.00***
		Contingency (30% of Construction Cost)			$ 89,100.00
		Engineering, Legal and Administration			$ 74,250.00
		Construction Management			$ 44,550.00
		Permitting			$ 14,850.00
		Project Cost Estimate			**$ 520,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 6 - NATURAL SEDIMENT TRAP (SWALE)
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 6,600.00	$ 6,600.00
2	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
3	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
4	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	2-01.5	Clearing and Grubbing	0.10 AC	$ 7,000.00	$ 707.07
7	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Drainage Channel, Incl. Haul	100 CY	$ 12.00	$ 1,200.00
8	2-03.5	Unsuitable Foundation Excavation	5 CY	$ 50.00	$ 250.00
9	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10	2-03.5	Bank Run Gravel for Trench Backfill	420 TN	$ 25.00	$ 10,500.00
11	2-12.5	Construction Geotextile for Soil Stabilization	280 SY	$ 3.00	$ 840.00
12	7-08.5	Dewatering	1 LS	$ 10,000.00	$ 10,000.00
13	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
14	8-02.5	Seeding, Fertilizing and Mulching	2,000 SY	$ 4.00	$ 8,000.00
15	8-02.5	Topsoil Type A	50 CY	$ 40.00	$ 2,000.00
16	8-15.5	Quarry Spalls	10 TN	$ 35.00	$ 350.00
17	8-15.5	River Rock	150 TN	$ 25.00	$ 3,750.00
18	8-02.5	Stream Buffer Enhancement	200 SY	$ 20.00	$ 4,000.00
19	8-02.5	Root Wad Buttress	50 SF	$ 41.00	$ 2,050.00
20	8-02.5	Log Cross Vanes	100 LF	$ 77.00	$ 7,700.00
21	8-15.5	Quarry Spalls	110 TN	$ 35.00	$ 3,850.00
		Subtotal			$ 83,597.07
		Sales Tax at 8.5%			$ 7,105.75
		Subtotal, Estimated Construction Cost			$ 90,702.82
		Construction Cost Estimate			***$ 91,000.00***
		Contingency (30% of Construction Cost)			$ 27,300.00
		Easement acquisition*	800 SF	$ 3.25	$ 2,600.00
		Engineering, Legal and Administration			$ 22,750.00
		Construction Management			$ 13,650.00
		Permitting			$ 4,550.00
		Project Cost Estimate			**$ 162,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 7 - SEDIMENT TRAP ON EITHER SIDE OF 74TH AVE NE
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY		UNIT PRICE		AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1	LS	$ 19,400.00	$	19,400.00
2	2-01.5	Clearing and Grubbing	0.03	AC	$ 7,000.00	$	176.77
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1	LS	$ 5,000.00	$	5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1	LS	$ 1,500.00	$	1,500.00
5	8-01.5	Temporary Erosion/Water Pollution Control	1	LS	$ 1,000.00	$	1,000.00
6	7-08.5	Trench Shoring and Excavation Safety	1	LS	$ 2,000.00	$	2,000.00
7	2-02.5	Removal of Structure and Obstructions	1	LS	$ 1,000.00	$	1,000.00
8	2-03.5	Temporary Bypass/Diversion	1	LS	$ 10,000.00	$	10,000.00
9	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Sediment Trap (Incl. Haul)	200	CY	$ 12.00	$	2,400.00
10	1-07.17	Locate and Protect Existing Utilities	1	LS	$ 1,500.00	$	1,500.00
11	7-17.3(3)	Bank Run Gravel for Trench Backfill	49	CY	$ 25.00	$	1,222.22
12	2-03.5	Unsuitable Foundation Excavation	3	CY	$ 50.00	$	134.44
13	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	60	LF	$ 131.00	$	7,860.00
14	2-02.3(4)	Sawcutting	240	LF	$ 3.00	$	720.00
15	8-02.5	Landscape Removal/Restoration	1	LS	$ 5,000.00	$	5,000.00
16	6-06.5	Precast Concrete Sediment Vault	1	LS	$ 187,500.00	$	187,500.00
17	8-02.5	Seeding, Fertilizing and Mulching	0	SY	$ 4.00	$	-
18	8-15.5	Quarry Spalls	10	TN	$ 35.00	$	350.00
19	7-08.3(1)C	Compaction Testing	1	EA	$ 12.00	$	12.00
		Subtotal				$	246,775.43
		Sales Tax at 8.5%				$	20,975.91
		Subtotal, Estimated Construction Cost				$	267,751.35
		Construction Cost Estimate				***$***	***268,000.00***
		Contingency (30% of Construction Cost)				$	80,400.00
		Easement acquisition*	800	SF	$ 9.00	$	7,200.00
		Engineering, Legal and Administration				$	67,000.00
		Construction Management				$	40,200.00
		Permitting				$	13,400.00
		Project Cost Estimate				**$**	**477,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 8 - ENLARGE EXISTING SEDIMENT TRAP (NE 170th ST)
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 32,800.00	$ 32,800.00
2	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
3	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
4	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
5	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
6	2-02.5	Removal of Structure and Obstructions	1 LS	$ 5,000.00	$ 5,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1 LS	$ 2,000.00	$ 2,000.00
8	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
9	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading for Sediment trap facility (Incl. Haul)	1,155 CY	$ 12.00	$ 13,860.00
10	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
11		Reconnect to Existing Storm Drainage System	3 EA	$ 1,000.00	$ 3,000.00
12	7-17.3(3)	Bank Run Gravel for Trench Backfill	133 CY	$ 25.00	$ 3,333.33
13	2-03.5	Unsuitable Foundation Excavation	20 CY	$ 50.00	$ 1,000.00
14		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
15	7-02.5	DI Culvert Pipe 24 In. Diam. (Incl. Bedding)	70 LF	$ 131.00	$ 9,170.00
16	2-02.3(4)	Sawcutting	302 LF	$ 3.00	$ 906.00
17	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	77 SY	$ 110.00	$ 8,466.64
18	4-04.5	Crushed Surfacing Base Course	12 TN	$ 35.00	$ 423.50
19	4-04.5	Crushed Surfacing Top Course	46 TN	$ 25.00	$ 1,154.54
20		Asphalt Treated Base	31 TN	$ 110.00	$ 3,386.66
21		Remove/Replace Concrete Sidewalk	12 SY	$ 50.00	$ 611.11
22	8-04	Remove/Replace Concrete Curb and Gutter	22 LF	$ 50.00	$ 1,100.00
23	8-22	Restore Pavement Marking	1 LS	$ 100.00	$ 100.00
24	8-02.5	Landscape Removal/Restoration	1 LS	$ 5,000.00	$ 5,000.00
25	6-06.5	Precast Concrete Sediment Vault	1 LS	$ 300,000.00	$ 300,000.00
26	8-15.5	Quarry Spalls	11 TN	$ 35.00	$ 385.00
27	7-08.3(1)C	Compaction Testing	1 EA	$ 12.00	$ 12.00
		Subtotal			$ 418,508.78
		Sales Tax at 8.5%			$ 35,573.25
		Subtotal, Estimated Construction Cost			$ 454,082.03
		Construction Cost Estimate			***$ 455,000.00***
		Contingency (30% of Construction Cost)			$ 136,500.00
		Engineering, Legal and Administration			$ 113,750.00
		Construction Management			$ 68,250.00
		Permitting			$ 22,750.00
		Project Cost Estimate			**$ 797,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.

CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 9 - BOX CULVERT CONSTRUCTION & NATURAL SEDIMENT TRAP W/IN TRACT C (WILDCLIFFE
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1 LS	$ 25,700.00	$ 25,700.00
2	2-01.5	Clearing and Grubbing	0.13 AC	$ 7,000.00	$ 883.84
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1 LS	$ 5,000.00	$ 5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1 LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1 LS	$ 2,800.00	$ 2,800.00
6	8-01.5	Temporary Erosion/Water Pollution Control	1 LS	$ 1,000.00	$ 1,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1 LS	$ 2,000.00	$ 2,000.00
8	2-02.5	Removal of Structure and Obstructions	1 LS	$ 7,000.00	$ 7,000.00
9	2-03.5	Temporary Bypass/Diversion	1 LS	$ 10,000.00	$ 10,000.00
10	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading - For Sediment trap and Trench (Incl. Haul)	1,000 CY	$ 12.00	$ 12,000.00
11	1-07.17	Locate and Protect Existing Utilities	1 LS	$ 1,500.00	$ 1,500.00
12	7-17.3(3)	Bank Run Gravel for Trench Backfill	453 CY	$ 25.00	$ 11,325.93
13	2-03.5	Unsuitable Foundation Excavation	53 CY	$ 50.00	$ 2,666.67
14		Sanitary Sewer Crossing Encasement	1 LS	$ 5,000.00	$ 5,000.00
15	2-02.3(4)	Sawcutting	264 LF	$ 3.00	$ 792.00
16	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	13 TN	$ 110.00	$ 1,452.00
17	4-04.5	Crushed Surfacing Base Course	18 TN	$ 35.00	$ 616.00
18	4-04.5	Crushed Surfacing Top Course	26 TN	$ 25.00	$ 660.00
19		Asphalt Treated Base	9 TN	$ 110.00	$ 968.00
20		Remove/Replace Concrete Sidewalk	15 SY	$ 50.00	$ 733.33
21	8-04	Remove/Replace Concrete Curb and Gutter	26 LF	$ 30.00	$ 792.00
22	8-22	Restore Pavement Marking	33 LF	$ 0.50	$ 16.50
23	8-02.5	Landscape Removal/Restoration	1 LS	$ 5,000.00	$ 5,000.00
24	8-02.5	Topsoil Type A	40 CY	$ 40.00	$ 1,600.00
25		Streambank Stabilization and Restoration	1 LS	$ 10,000.00	$ 10,000.00
26	8-02.5	Root Wad Buttress	500 SF	$ 50.00	$ 25,000.00
27	6-06.5	Precast 8' x 8' Box Culvert (incl bedding)	230 LF	$ 800.00	$ 184,000.00
28		Reconnect to Existing Storm Drainage System	1 EA	$ 1,000.00	$ 1,000.00
29	8-15.5	Quarry Spalls (Outlet Pad and Rock Check Dams)	10 TN	$ 35.00	$ 350.00
30	8-02.5	Seeding, Fertilizing and Mulching	350 SY	$ 4.00	$ 1,400.00
31		Minor Changes	1 LS	$ 5,000.00	$ 5,000.00
		Subtotal			$ 327,756.26
		Sales Tax at 8.5%			$ 27,859.28
		Subtotal, Estimated Construction Cost			$ 355,615.55
		Construction Cost Estimate			***$ 356,000.00***
		Contingency (30% of Construction Cost)			$ 106,800.00
		Easement acquisition*	3,750 SF	$ 6.84	$ 25,650.00
		Engineering, Legal and Administration			$ 89,000.00
		Construction Management			$ 53,400.00
		Permitting			$ 17,800.00
		Project Cost Estimate			**$ 649,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = Easement area/Parcel area * Parcel value per King County Assessors *75%

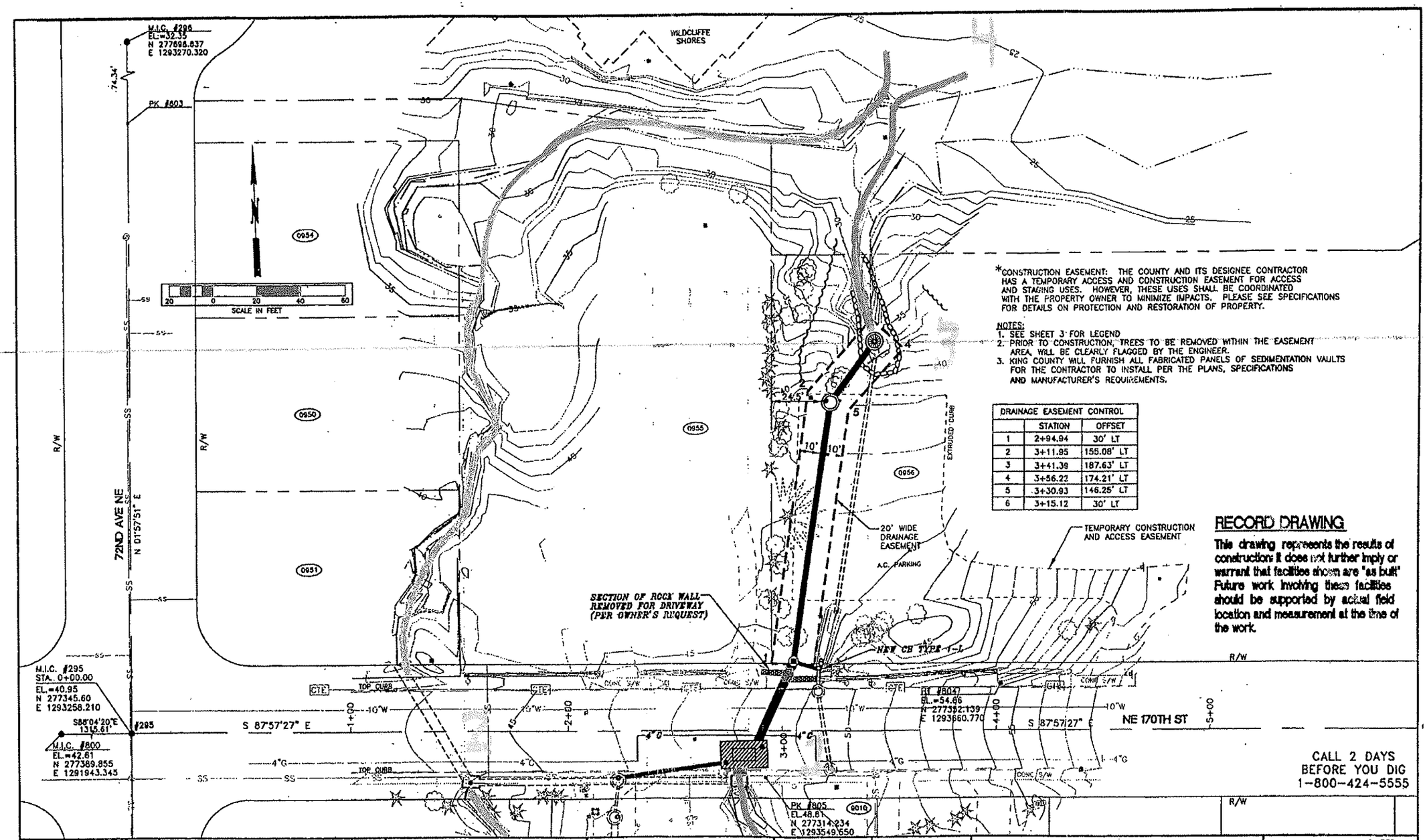
CITY OF KENMORE - TRIBUTARY 057 AND TRIB-1 SEDIMENT STUDY
AREA 10 - ECOLOGY BLOCK WALL CONSTRUCTION & NATURAL SEDIMENT TRAP W/IN TRACT C
G&O #09517
CONSTRUCTION COST ESTIMATE - APRIL 2010

NO.	Spec No.	DESCRIPTION	QUANTITY		UNIT PRICE	AMOUNT
1	1-09.7	Mobilization, Cleanup, and Demobilization	1	LS	$ 21,200.00	$ 21,200.00
2	2-01.5	Clearing and Grubbing	0.20	AC	$ 7,000.00	$ 1,400.00
3	1-05.4(2)	Construction Surveying, Staking, and As-Built Drawings	1	LS	$ 5,000.00	$ 5,000.00
4	1-07.15(1)	Spill Prevention Control and Countermeasures Plan	1	LS	$ 1,500.00	$ 1,500.00
5	1-10.4(1)	Project Temporary Traffic Control	1	LS	$ 2,800.00	$ 2,800.00
6	8-01.5	Temporary Erosion/Water Pollution Control	1	LS	$ 1,000.00	$ 1,000.00
7	7-08.5	Trench Shoring and Excavation Safety	1	LS	$ 2,000.00	$ 2,000.00
8	2-02.5	Removal of Structure and Obstructions	1	LS	$ 7,000.00	$ 7,000.00
9	2-03.5	Temporary Bypass/Diversion	1	LS	$ 10,000.00	$ 10,000.00
10	2-03.5	Excavation and Haul, Backfill, and Compaction and Grading - For Sediment trap and Trench (Incl. Haul)	1,000	CY	$ 12.00	$ 12,000.00
11	1-07.17	Locate and Protect Existing Utilities	1	LS	$ 1,500.00	$ 1,500.00
12	7-17.3(3)	Bank Run Gravel for Trench Backfill	460	CY	$ 25.00	$ 11,500.00
13	2-03.5	Unsuitable Foundation Excavation	55	CY	$ 50.00	$ 2,750.00
14		Sanitary Sewer Crossing Encasement	1	LS	$ 5,000.00	$ 5,000.00
15	2-02.3(4)	Sawcutting	265	LF	$ 3.00	$ 795.00
16	5-04.3(9)	Hot Mix Asphalt (HMA) Class 1/2"	20	TN	$ 110.00	$ 2,200.00
17	4-04.5	Crushed Surfacing Base Course	35	TN	$ 30.00	$ 1,050.00
18	4-04.5	Crushed Surfacing Top Course	35	TN	$ 35.00	$ 1,225.00
19		Asphalt Treated Base	15	TN	$ 110.00	$ 1,650.00
20		Remove/Replace Concrete Sidewalk	15	SY	$ 50.00	$ 750.00
21	8-04	Remove/Replace Concrete Curb and Gutter	30	LF	$ 30.00	$ 900.00
22	8-22	Restore Pavement Marking	35	LF	$ 0.50	$ 17.50
23	8-02.5	Landscape Removal/Restoration	1	LS	$ 5,000.00	$ 5,000.00
24	8-02.5	Topsoil Type A	40	CY	$ 40.00	$ 1,600.00
25		Streambank Stabilization and Restoration	1	LS	$ 10,000.00	$ 10,000.00
26	6-06.5	Precast 8' x 8' Box Culvert (incl bedding)	75	LF	$ 850.00	$ 63,750.00
27	8-02.5	Root Wad Buttress	500	SF	$ 50.00	$ 25,000.00
28		Reconnect to Existing Storm Drainage System	1	EA	$ 1,000.00	$ 1,000.00
29		Ecology Blocks	2,580	SF	$ 25.00	$ 64,500.00
30	8-15.5	Quarry Spalls (Outlet Pad and Rock Check Dams)	10	TN	$ 35.00	$ 350.00
31	8-02.5	Seeding, Fertilizing and Mulching	200	SY	$ 4.00	$ 800.00
32		Minor Changes	1	LS	$ 5,000.00	$ 5,000.00
		Subtotal				$ 270,237.50
		Sales Tax at 8.5%				$ 22,970.19
		Subtotal, Estimated Construction Cost				$ 293,207.69
		Construction Cost Estimate				***$ 294,000.00***
		Contingency (30% of Construction Cost)				$ 88,200.00
		Easement acquisition*	5,650	SF	$ 7.57	$ 42,770.50
		Engineering, Legal and Administration				$ 73,500.00
		Construction Management				$ 44,100.00
		Permitting				$ 14,700.00
		Project Cost Estimate				**$ 558,000.00**

Prepared by: Elissa Backholm, P.E.
Checked by: Barry Baker, P.E.
*Easement acquisition value equation = sum of Easement area/sum of Parcel area * Parcel value per King County Assessors*75%

APPENDIX E

EXISTING SEDIMENT VAULT AS-BUILT DRAWINGS (KING COUNTY)



*CONSTRUCTION EASEMENT: THE COUNTY AND ITS DESIGNEE CONTRACTOR HAS A TEMPORARY ACCESS AND CONSTRUCTION EASEMENT FOR ACCESS AND STAGING USES. HOWEVER, THESE USES SHALL BE COORDINATED WITH THE PROPERTY OWNER TO MINIMIZE IMPACTS. PLEASE SEE SPECIFICATIONS FOR DETAILS ON PROTECTION AND RESTORATION OF PROPERTY.

NOTES:
1. SEE SHEET 3 FOR LEGEND
2. PRIOR TO CONSTRUCTION, TREES TO BE REMOVED WITHIN THE EASEMENT AREA, WILL BE CLEARLY FLAGGED BY THE ENGINEER.
3. KING COUNTY WILL FURNISH ALL FABRICATED PANELS OF SEDIMENTATION VAULTS FOR THE CONTRACTOR TO INSTALL PER THE PLANS, SPECIFICATIONS AND MANUFACTURER'S REQUIREMENTS.

DRAINAGE EASEMENT CONTROL		
	STATION	OFFSET
1	2+94.94	30' LT
2	3+11.95	155.08' LT
3	3+41.39	187.63' LT
4	3+56.22	174.21' LT
5	3+30.93	146.25' LT
6	3+15.12	30' LT

RECORD DRAWING

This drawing represents the results of construction. It does not further imply or warrant that facilities shown are "as built". Future work involving these facilities should be supported by actual field location and measurement at the time of the work.

CALL 2 DAYS BEFORE YOU DIG 1-800-424-5555

SURVEYED: HILLEBRAND	3/97	RECORD CHANGES MADE TO VAULT LOCATION, NEW CB TYPE 1-L AND EXISTING ROCK WALL AND GAS LINE	F.B.	7/98	
BASE MAP PLOT: WJS	5/97				
DESIGN PLOT: TRAXINGER, L.	X/98				
CHECKED: WOH	5/97				
FIELD BOOK: 19189	3/97				
BY	DATE	REVISION	BY	DATE	

APPROVED: LARRY R. GIBBONS DATE: 6/98
PROJECT MANAGER: MIKE TSENG DATE: 6/98
DESIGNED: JOHN ABDALKHAN DATE: 6/98
ECOLOGIST: FRAN SOLOMON DATE: 6/98
DRAWN: LUCY TRAXINGER DATE: 6/98

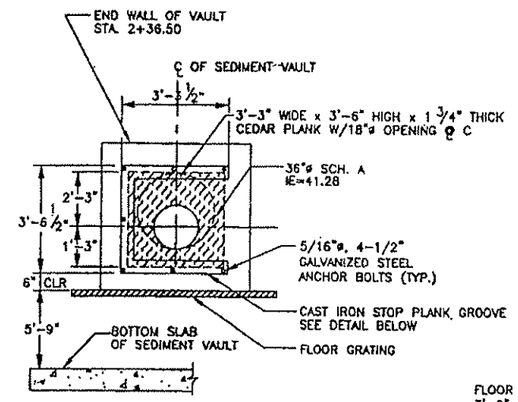
PROJECT No. 981175
SURVEY No. 12-26-4-43
MAINTENANCE DIVISION No. 1

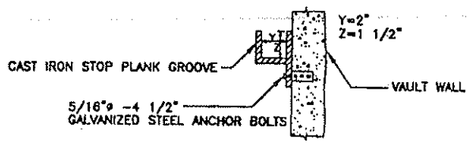
LARRY R. GIBBONS — STATE OF WASHINGTON — 15560 — REGISTERED PROFESSIONAL ENGINEER
EXPIRES 4/13/2000

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
WILDCLIFFE SHORES DRAINAGE IMPROVEMENT
SITE CONTROL PLAN

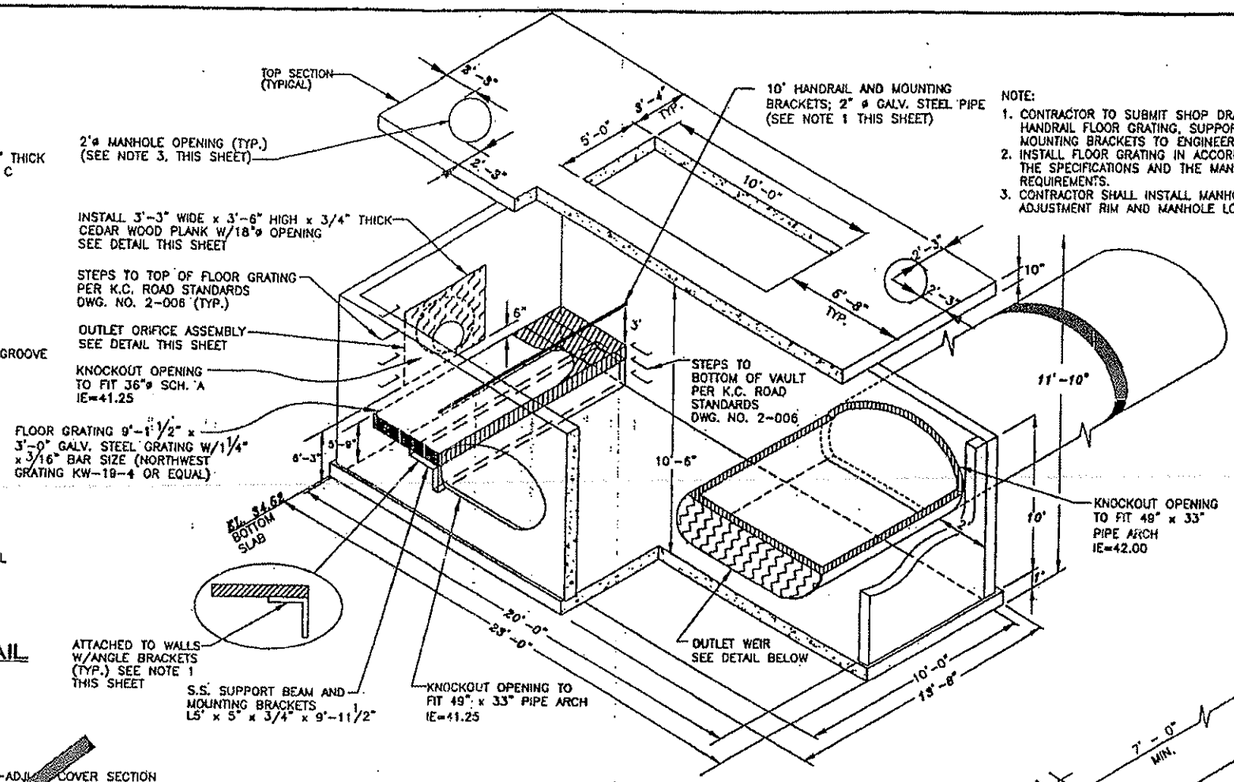
SHEET 2 OF 5 SHEETS
MAP-NO 2002-99 (2)

I:\LUCY\ASBUILT_KEEP\WILDCLIFF\WILDCTRL, Wed Jul 14 14:22:32 1999



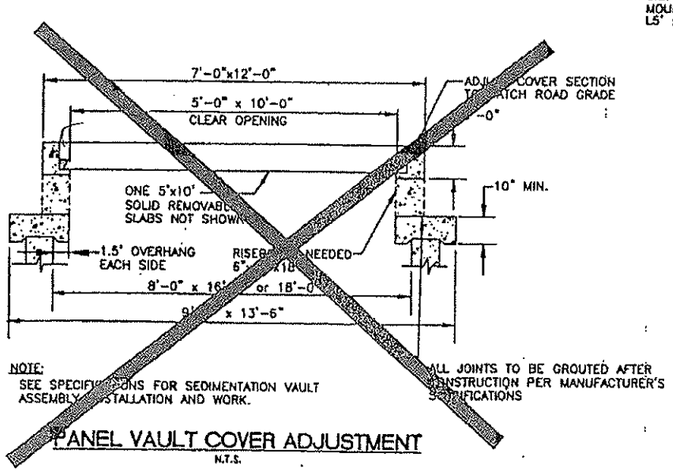


OUTLET ORIFICE ASSEMBLY DETAIL
N.T.S.



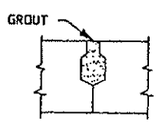
NOTE:
1. CONTRACTOR TO SUBMIT SHOP DRAWINGS OF HANDRAIL FLOOR GRATING, SUPPORT BEAM AND MOUNTING BRACKETS TO ENGINEER FOR APPROVAL.
2. INSTALL FLOOR GRATING IN ACCORDANCE WITH THE SPECIFICATIONS AND THE MANUFACTURER'S REQUIREMENTS.
3. CONTRACTOR SHALL INSTALL MANHOLE RISER ADJUSTMENT RIM AND MANHOLE LOCKING LIDS.

PANEL-SEDIMENTATION VAULT (1/4)
20' LONG @ STA. 2+71 TO STA. 2+90.3
N.T.S.

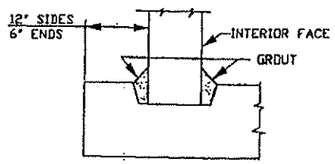


NOTE:
SEE SPECIFICATIONS FOR SEDIMENTATION VAULT ASSEMBLY, INSTALLATION AND WORK.

PANEL VAULT COVER ADJUSTMENT
N.T.S.

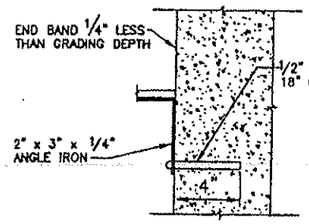


DECK BASE KEY DETAIL
TYPICAL BETWEEN TOP SECTIONS AND BETWEEN BASE SECTIONS
N.T.S.

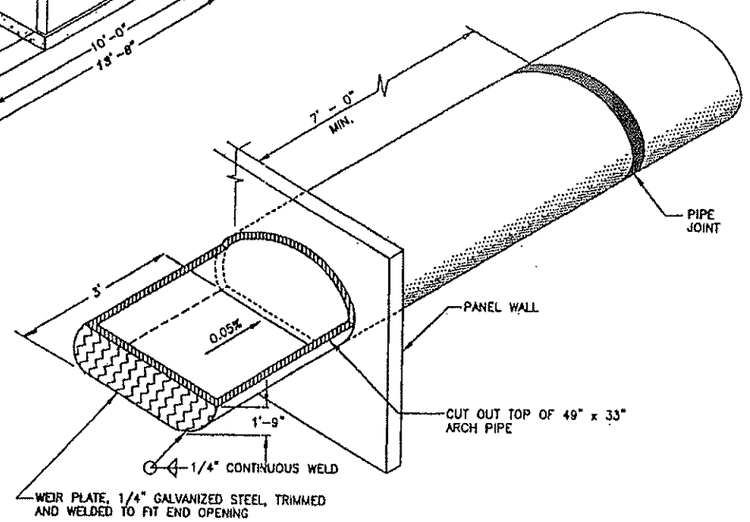


TYPICAL FOOTING KEY DETAIL
N.T.S.

SEDIMENT VAULT ASSEMBLY DETAILS
N.T.S.



GRATING SUPPORT AT CONCRETE
N.T.S.



OUTLET WEIR ASSEMBLY DETAIL
N.T.S.

RECORD DRAWING

This drawing represents the results of construction it does not further imply or warrant that facilities shown are "as built" Future work involving these facilities should be supported by actual field location and measurement at the time of the work.

CALL 2 DAYS BEFORE YOU DIG 1-800-424-5555

SURVEYED: HILLEBRAND	3/97	RECORD CHANGES TO VAULT DIMENSIONS	F.B.	7/98
BASE MAP PLOT: WJS	5/97			
DESIGN PLOT: TRAXINGER, L.	4/98			
CHECKED: WOM	5/97			
FIELD BOOK: 1618Q	3/97			
BY	DATE	REVISION	BY	DATE

APPROVED: LARRY R. GIBBONS DATE: 6/98
PROJECT MANAGER: MIKE TSENG DATE: 6/98
PROJECT ENGINEER: JOHN ABDALKHANI DATE: 6/98
ECOLOGIST: FRAN SOLOMON DATE: 6/98
DRAWN: TRAXINGER, L./ WHITFIELD, M. DATE: 6/98

PROJECT No. 091175
SURVEY No. 12-26-4-43
MAINTENANCE DIVISION No. 1

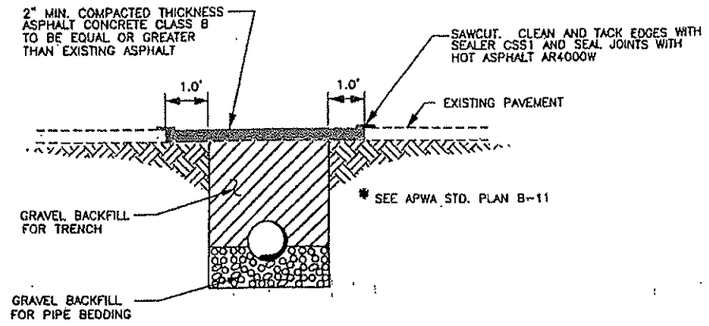
LARRY R. GIBBONS — STATE OF WASHINGTON — 13668 — REGISTERED PROFESSIONAL ENGINEER
EXPIRES 4/23/2000

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
WILDCLIFFE SHORES DRAINAGE IMPROVEMENT
SEDIMENT VAULT ASSEMBLY DETAILS

SHEET 4 OF 5 SHEETS

MAP-NO 2002-99 (4)

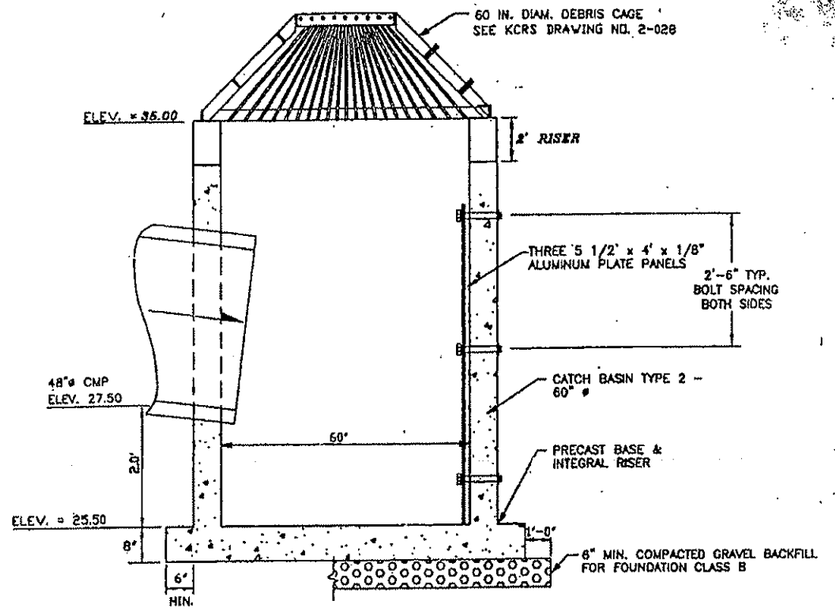
J:\LOTS\WILDCLIFF_KEEP\WILDCLIFF\WILDCLIFF.dgn Jul 14 14:18:29 1998



PIPE TRENCH DETAIL (TYP.)

NE 170TH ST

N.T.S.

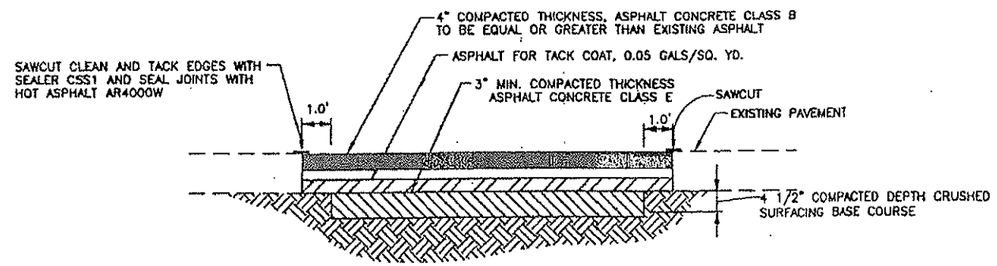


ENERGY DISSIPATOR STRUCTURE - 60 IN. DIAM.

STA. 4+80.00 N.T.S.

RECORD DRAWING

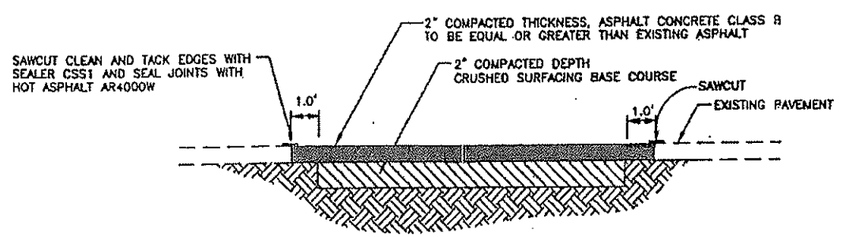
This drawing represents the results of construction it does not further imply or warrant that facilities shown are "as built" Future work involving these facilities should be supported by actual field location and measurement at the time of the work.



PAVEMENT REPLACEMENT DETAIL (TYP.)

NE 170 ST

N.T.S.



PAVEMENT REPLACEMENT DETAIL (TYP.)

EASTER SEAL'S PARKING LOT

N.T.S.

CALL 2 DAYS BEFORE YOU DIG 1-800-424-5555

SURVEYED: HILLEBRAND	3/97	RECORD CHANGES TO ENERGY DISSIPATOR	F.B.	7/99	
BASE MAP PLOT: WJS	5/97				
DESIGN PLOT: TRAXINGER, L.	4/98				
CHECKED: WOM	5/97				
FIELD BOOK: 16180	3/97				
BY	DATE	REVISION	BY	DATE	

APPROVED: LARRY R. GIBBONS DATE: 6/98
PROJECT MANAGER: MIKE TSENG DATE: 6/98
DESIGNED: JOHN ABDALKHANI DATE: 6/98
ECOLOGIST: FRAN SOLOMON DATE: 6/98
DRAWN: LUCY TRAXINGER DATE: 6/98

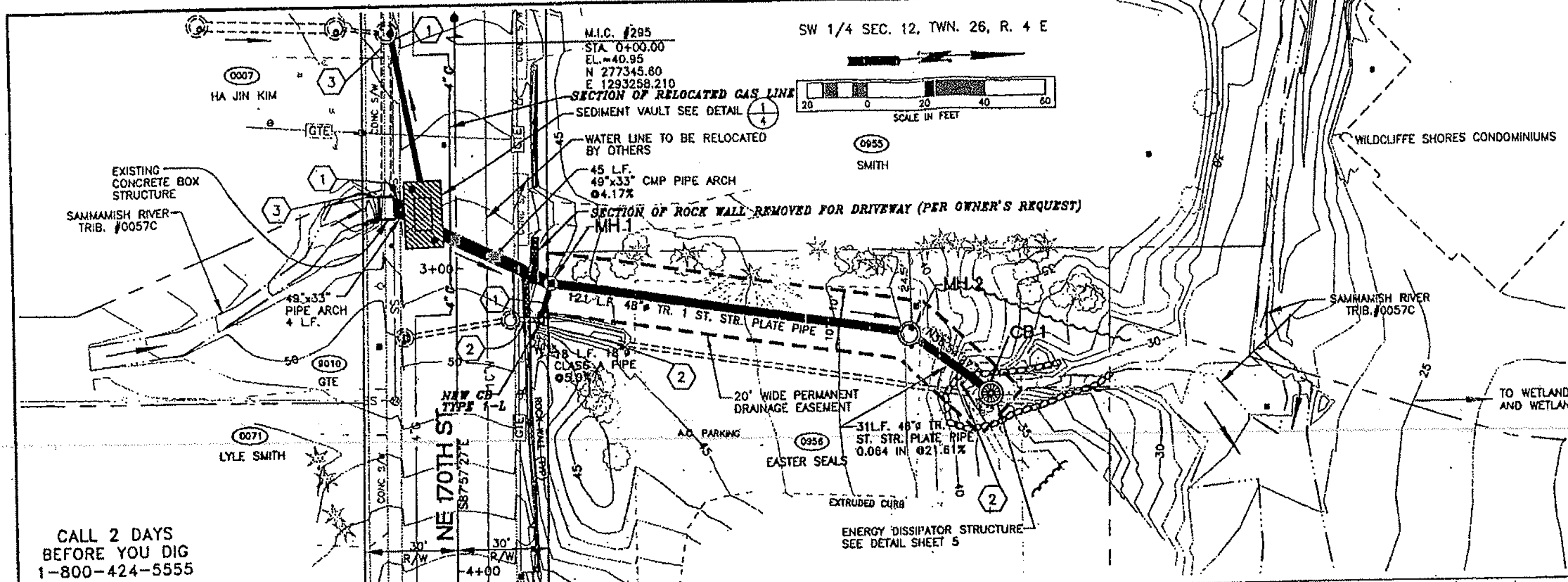
PROJECT No. 081175
SURVEY No. 12-26-4-43
MAINTENANCE DIVISION No. 1

LARRY R. GIBBONS STATE OF WASHINGTON 13600 REGISTERED PROFESSIONAL ENGINEER
EXPIRES 4/23/2000

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
WILDCLIFFE SHORES DRAINAGE IMPROVEMENT
MISCELLANEOUS DETAILS

SHEET 5 OF 5 SHEETS

MAP-NO 2002-99 (6)



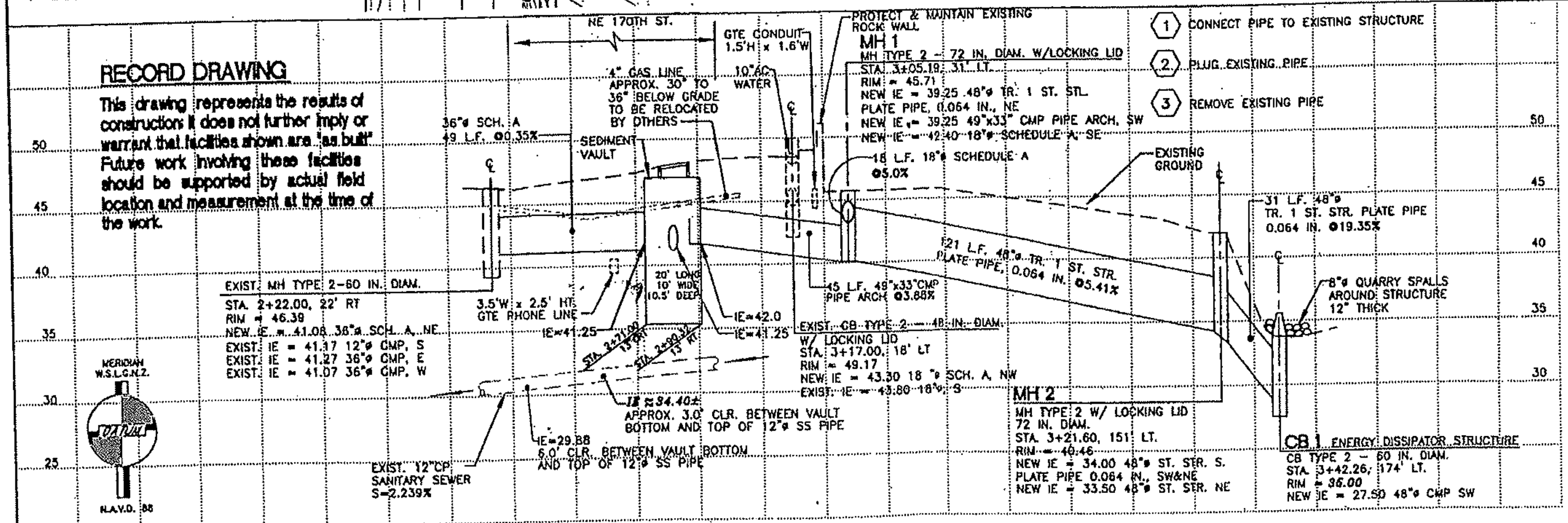
LEGEND

- EDGE OF ASPHALT CONCRETE
- EXISTING FENCE
- P/L PROPERTY LINE
- STREAM
- EASEMENT LINE
- G — GAS LINE
- W — WATER LINE
- SS — SANITARY SEWER
- TV — CABLE
- 377 — EXISTING CONTOUR
- EXISTING DRAINAGE PIPE
- NEW DRAINAGE PIPE
- DIRECTION OF FLOW
- GTE — BURIED TELEPHONE CABLES
- POWER POLE
- NEW CATCH BASIN
- EXISTING CATCH BASIN-TYPE 2
- EXISTING CATCH BASIN-TYPE 1
- SURVEY HUB & TACK
- SURVEY PKS
- CONSTRUCTION NOTE NO.
- DECIDUOUS TREE
- CONIFEROUS TREE
- LANDSCAPE AREA
- SURVEY MARKER

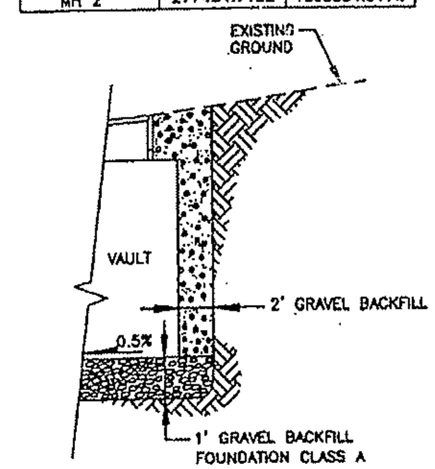
1. CONNECT PIPE TO EXISTING STRUCTURE
2. PLUG EXISTING PIPE
3. REMOVE EXISTING PIPE

RECORD DRAWING

This drawing represents the results of construction. It does not further imply or warrant that facilities shown are "as built". Future work involving these facilities should be supported by actual field location and measurement at the time of the work.



DRAINAGE STRUCTURE COORDINATE TABLE		
STRUCTURE #	NORTHING	EASTING
CB 1	277506.6026	1293606.2718
MH 1	277365.8691	1293564.3141
MH 2	277484.7152	1293584.8172



VAULT EXCAVATION DETAIL (TYP.)

N.T.S.

SURVEYED: HILLEBRAND	3/97	RECORD CHANGES MADE TO VAULT LOCATION, PIPE CONNECTION #1, EXISTING ROCK WALL AND GAS LINE	F.B.	7/99	
BASE MAP PLOT: WJS	3/97				
DESIGN PLOT: TRAXINGER, L.	4/98				
CHECKED: WDM	5/97				
FIELD BOOK: 16180	3/97				
	BY	DATE	REVISION	BY	DATE

APPROVED: LARRY R. GIBBONS DATE: 6/98
PROJECT MANAGER: MIKE TSENG DATE: 6/98
DESIGNED: JOHN ABDALKHANI DATE: 6/98
ECOLOGIST: FRAN SOLOMON DATE: 6/95
DRAWN: LUCY TRAXINGER DATE: 6/98

PROJECT No. 081175
SURVEY No. 12-26-4-43
MAINTENANCE DIVISION No. 1

LARRY R. GIBBONS — PROFESSIONAL ENGINEER — EXPIRES 4/23/2000

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

WILDCLIFFE SHORES DRAINAGE IMPROVEMENT
PLAN AND PROFILE

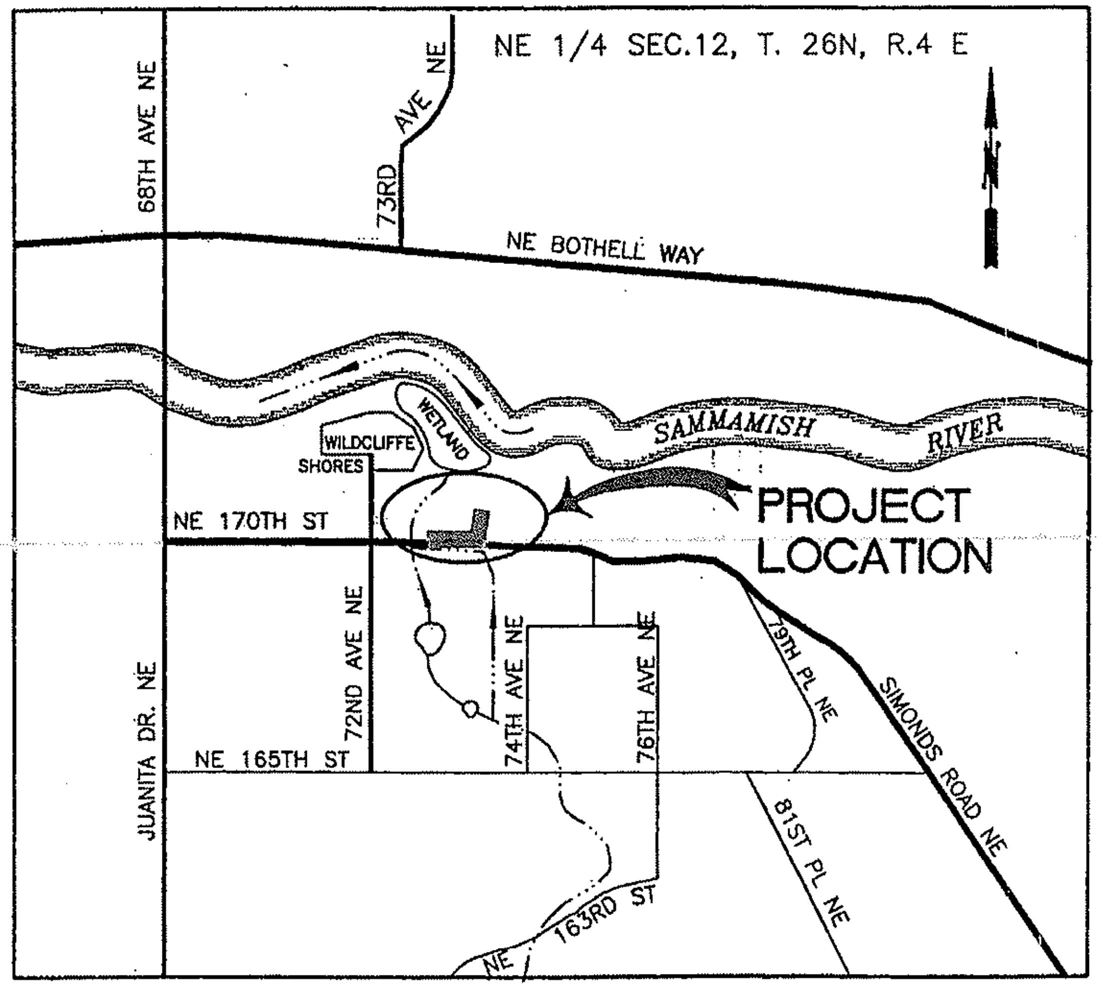
SHEET 3 OF 5 SHEETS

MAP-NO 2002-99 (3)

RECORD DRAWING

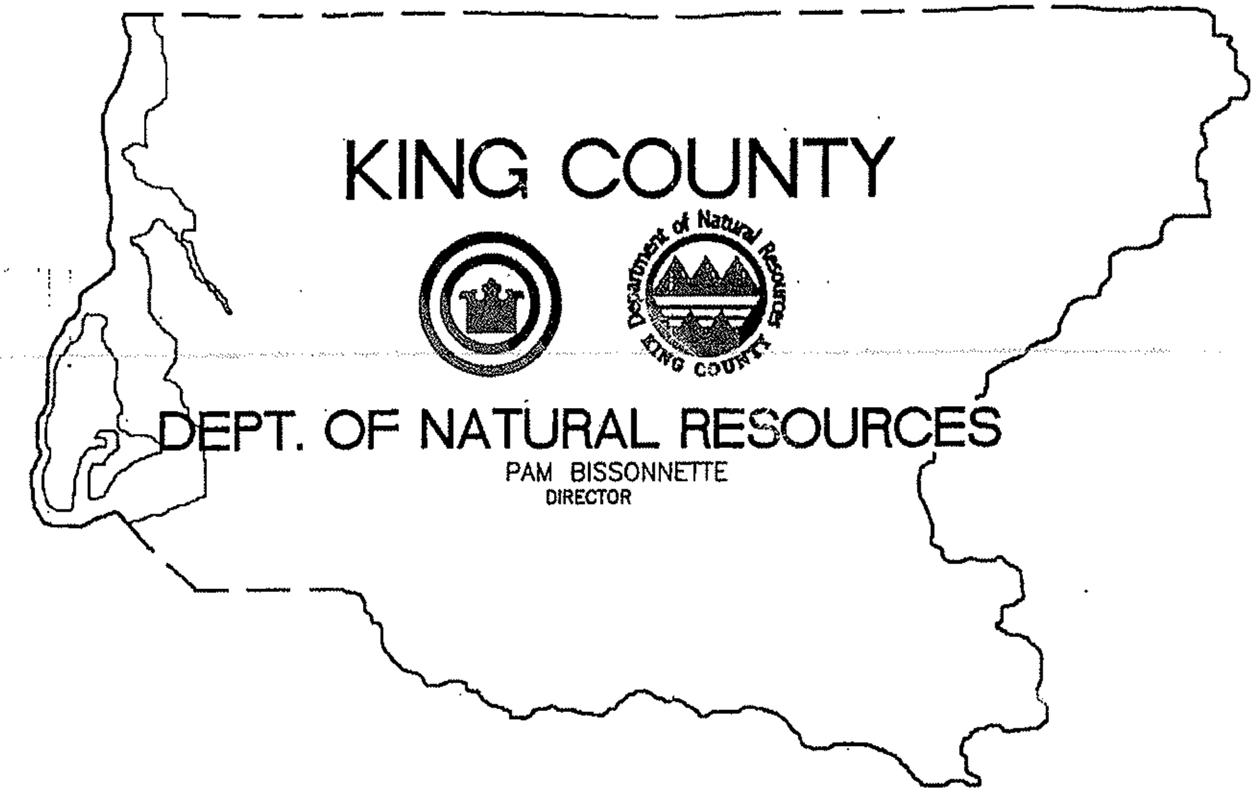
This drawing represents the results of construction; it does not further imply or warrant that facilities shown are "as built". Future work involving these facilities should be supported by actual field location and measurement at the time of the work.

VICINITY MAP



INDEX

SHEET	DESCRIPTION
1	COVER SHEET
2	SITE CONTROL PLAN
3	PLAN AND PROFILE
4	SEDIMENT VAULT ASSEMBLY DETAILS
5	DETAILS – MISCELLANEOUS DETAILS



WILDCLIFFE SHORES DRAINAGE IMPROVEMENT

(NE 170TH ST NEAR 72ND AVE NE)

CALL 2 DAYS BEFORE YOU DIG 1-800-424-5555

SURVEYED: HILLEBRAND	3/97	
BASE MAP PLOT: WJS	5/97	
DESIGN PLOT: TRAXINGER, L.	4/98	
CHECKED: WOM	5/97	
FIELD BOOK: 18180	3/97	
BY	DATE	REVISION / BY / DATE

APPROVED: LARRY R. GIBBONS DATE: 6/98
PROJECT MANAGER: MIKE TSENG DATE: 6/98
DESIGNED: JOHN ABDALKHANI DATE: 5/98
ECOLOGIST: FRAN SOLOMON DATE: 5/98
DRAWN: LUCY TRAXINGER DATE: 6/98

PROJECT No. 201175
SURVEY No. 12-26-4-43
MAINTENANCE DIVISION No. 1

EXPIRES 4/23/2000

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
WILDCLIFFE SHORES DRAINAGE IMPROVEMENT
COVER SHEET

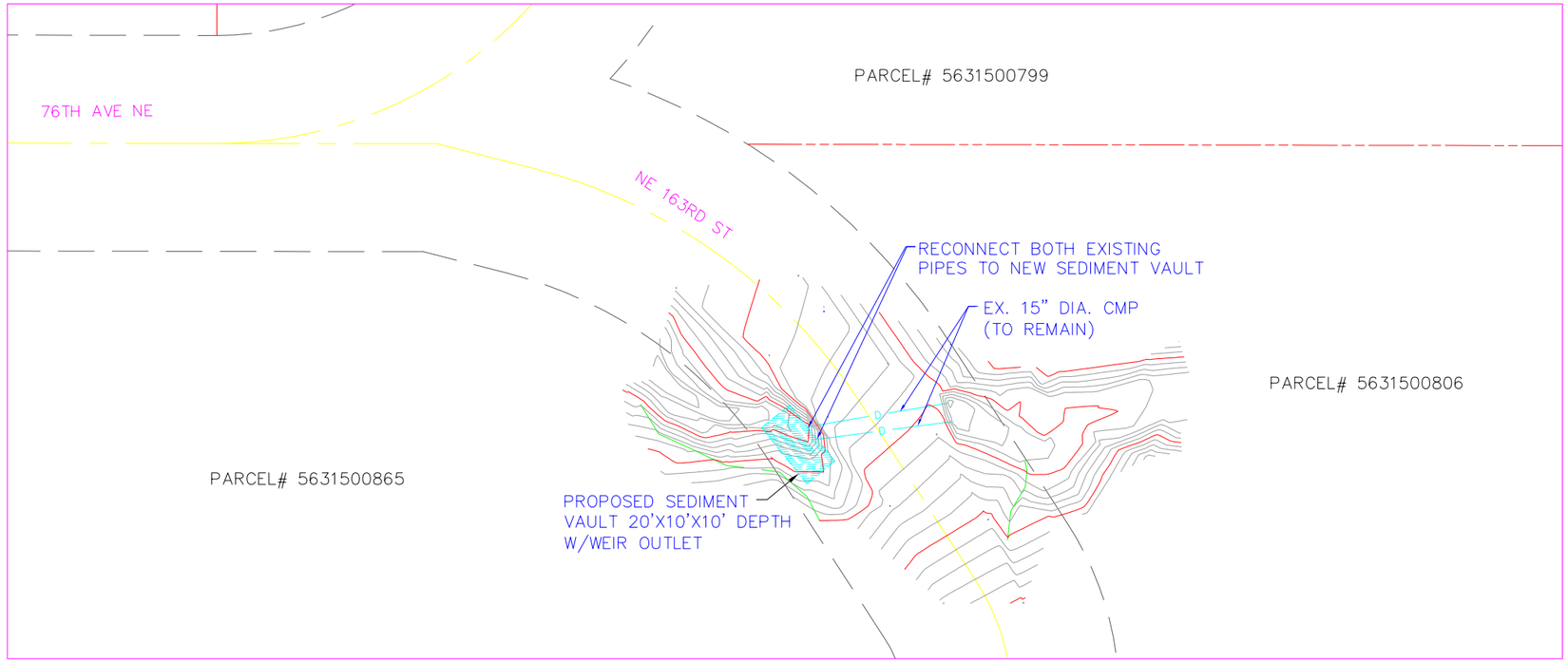
SHEET 1 OF 5 SHEETS

MAP-NO 2002-99 (1)

APPENDIX F

CAPITAL IMPROVEMENT PROJECT LOCATION PLAN SHEETS

20' 10' 0 20' 40'



NOTE:
EXISTING PIPE LOCATION FROM KING COUNTY ASBUILT DRANINGS

No.	DATE	BY	REVISION

BARRY P. BAKER STATE OF WASHINGTON 37338 REGISTERED PROFESSIONAL ENGINEER

Scale:
Horiz: 1"=20'
Vert: 1"=10'

Designed By: B.P.B.
Drawn By: P.G.M.
Reviewed By: B.P.B.
Date: February. 2010

KENMORE

City of Kenmore

PUBLIC WORKS DEPARTMENT

6700 NE 181st St - PO Box 82607, Kenmore WA 98028
425-398-8900 - Fax: 425-481-3236

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH SUITE 200
SEATTLE, WASHINGTON 98109 - (206) 284-0860

Tributary 57
Basin Sediment Study

09517

PLAN
ALTERNATIVE
5

Sheet No.
X
Of Total

20' 10' 0 20' 40'

PARCEL# 5634500630

PARCEL# 5634500956

PARCEL# 5634500071

EXISTING STREEM PATH TO WETLAND

EXISTING QUARRY SPAILS (TO REMAIN)

EX. TYPE II CB W/BIRD CAGE (TO REMAIN)

EX. 48" PIPES (TO REMAIN)

EXISTING 20' DRAINAGE EASEMENT

EX. TYPE II CB (TO REMAIN)

RECONECT EXISTING PIPE TO NEW SEDLMANT VAULT

PROPOSED SEDIMENT VAULT (20'X28'X10' DEPTH) WITH WEIR OUTLET

VICINITY OF SEVERE INCISING. STREAM ENHANCEMENT RECOMMENDED.

EX. PIPE (TO BE REMOVED)

END OF PROPOSED BOX CULVERT

EX. TYPE II CB (TO REMAIN)

EXISTING 49X33 CMP PIPE ARCH

EX. SEDIMENT VAULT (TO BE REMOVED)

EX. PIPE (TO BE ABANDONED)

PARCEL# 5634500955

PARCEL# 5634500007

170TH AVE NE

PARCEL# 5634500620

PARCEL# 5634500003

PARCEL# 5634500005

PARCEL# 5634500954

PARCEL# 5634500950

PARCEL# 5634500951

NOTE:
EXISTING PIPE LOCATION FROM KING COUNTY ASBUILT DRANINGS

No.	DATE	BY	REVISION

HARRY P. BAILEY STATE OF WASHINGTON 37338 REGISTERED PROFESSIONAL ENGINEER

Scale:
Horiz: 1"=20'
Vert: 1"=10'

Designed By: B.P.B.

Drawn By: P.G.M.

Reviewed By: B.P.B.

Date: February. 2010

KENMORE

City of Kenmore

PUBLIC WORKS DEPARTMENT

6700 NE 181st St - PO Box 82607, Kenmore WA 98028
425-398-8900 - Fax: 425-481-3236

Gray & Osborne, Inc.
CONSULTING ENGINEERS
701 DEXTER AVENUE NORTH, SUITE 200
SEATTLE, WASHINGTON 98109 - (206) 284-0860

Tributary 57
Basin Sediment Study

09517

PLAN
ALTERNATIVE
8

Sheet No.
X
Of Total

20' 10' 0 20' 40'

PARCEL# 5634500630

SEDIMENT MANAGMENT AREA

APPROXIMATE LOCATION OF STREAM ℄

EX. CHANNEL

EXISTING QUARRY SPALLS FOR ENERGY DISSIPATION (MOVE TO END OF BOX CULVERT)

EX. TYPE II CB W/BIRDCAGE (TO BE REMOVED)

EX. 48" PIPES (TO BE REMOVED)

20' DRAINAGE EASEMENT (TO REMAIN)

PROPOSED 8'X8' BOX CULVERT (TYP)

EX. TYPE II CB (TO BE REMOVED)

EXISTING PIPE (TO BE REMOVED)

PARCEL# 5634500956

PARCEL# 5634500071

VICINITY OF SEVERE INCISING. STREAM ENHANCEMENT RECOMMENDED.

ROOTWAD (TYP)

END OF PROPOSED BOX CULVERT

EX. TYPE II CB SDMH (TO BE REMOVED)

EXISTING 49X33 CMP PIPE ARCH

EX. PIPE (TO BE REMOVED)

EX. SEDIMENT VAULT (TO BE REMOVED)

EX. PIPE (TO BE ABANDONED)

PARCEL# 5634500955

PARCEL# 5634500007

PARCEL# 5634500620

PARCEL# 5634500954

PARCEL# 5634500950

PARCEL# 5634500951

170TH AVE NE

PARCEL# 5634500003

PARCEL# 5634500005

NOTE:
EXISTING PIPE LOCATION FROM KING COUNTY ASBUILT DRANINGS

No.	DATE	BY	REVISION

LARRY P. BAUER — STATE OF WASHINGTON — 37338 — REGISTERED PROFESSIONAL ENGINEER

Scale:
Horiz: 1"=20'
Vert: 1"=10'

Designed By: B.P.B.

Drawn By: P.G.M.

Reviewed By: B.P.B.

Date: February. 2010

KENMORE

City of Kenmore
PUBLIC WORKS DEPARTMENT
6700 NE 181st St - PO Box 82607, Kenmore WA 98028
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701 DEXTER AVENUE NORTH, SUITE 200
SEATTLE, WASHINGTON 98109 - (206) 284-0860

Tributary 57
Basin Sediment Study

09517

PLAN
ALTERNATIVE
9

Sheet No.
X
Of Total

20' 10' 0 20' 40'

PARCEL# 5634500956

SEDIMENT MANAGEMENT AREA

APPROXIMATE LOCATION OF STREAM ℄

PARCEL# 5634500630

ROOTWAD (TYP)

PROPOSED 8'x8' BOX CULVERT FOR ACCESS TO SEDIMENT POND

11' WIDE CHANNEL

PROPOSED 20' DRAINAGE EASEMENT

ECOLOGY BLOCK WALL (2.5'x2.5'x5.0')

PARCEL# 5634500955

PROPOSED 8'x8' BOX CULVERT

VICINITY OF SEVERE INCISING. STREAM ENHANCEMENT RECOMMENDED.

170TH AVE NE

PARCEL# 5634500620

PARCEL# 5634500954

PARCEL# 5634500950

PARCEL# 5634500951

PARCEL# 5634500003

PARCEL# 5634500005

NOTE:
EXISTING PIPE LOCATION FROM KING COUNTY ASBUILT DRANINGS

No.	DATE	BY	REVISION

BARRY P. BAKER STATE OF WASHINGTON 37338 REGISTERED PROFESSIONAL ENGINEER

Scale:
Horiz: 1"=20'
Vert: 1"=10'

Designed By: B.P.B.

Drawn By: P.G.M.

Reviewed By: B.P.B.

Date: February. 2010

KENMORE

City of Kenmore

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Tributary 57
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09517

PLAN
ALTERNATIVE
10

Sheet No.
X
Of Total