INITIAL INFILTRATION AND INFLOW REDUCTION PROJECT ALTERNATIVES ANALYSIS REPORT

Regional Infiltration and Inflow Control Program
King County, Washington

April 2009

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

King County

INITIAL INFILTRATION AND INFLOW REDUCTION PROJECT ALTERNATIVES ANALYSIS REPORT

APRIL 2009

Prepared for:

King County

Department of Natural Resources and Parks
Wastewater Treatment Division
201 South Jackson Street
Seattle, WA 98104
http://www.kingcounty.gov/wtd

Prepared by:

TETRA TECH

Engineering & Architecture Services
1420 Fifth Avenue, Suite 600, Seattle, WA 98101-2357
Tel 206.883.9300 Fax 206.883.9301 www.tetratech.com

Project #3630037

King County

Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report

TABLE OF CONTENTS

Appendices

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

TERMS

20-Year Peak Flow—A level of wastewater flow expected to be reached once every 20 years, on average, based on statistical analysis of historical rainfall and system flows; the 20-year peak flow is the design flow that King County conveyance facilities should be built to accommodate

Benefit/Cost Ratio—The ratio of savings associated with reduction or elimination of a conveyance system improvement project to the cost of the I/I reduction project that allows the reduction or elimination

Cost-Effective—Having a benefit/cost ratio of 1.0 or greater

Infiltration—Groundwater that enters a wastewater conveyance system through cracks or other defects in the buried infrastructure

Inflow—Precipitation runoff that enters a wastewater conveyance system through manholes, roof drains or other surface openings connecting to the system

Lateral—The portion of a pipe connecting a private property to the public sewer system that is in the public right of way

Mini-Basin—A drainage basin (geographic area encompassing all portions of the wastewater collection system draining to a single point) defined by King County's Regional I/I/ Control Program in order to establish manageable target areas for sewer system evaluation and rehabilitation. Mini-basins typically include about 20,000 feet of sewer main pipeline.

Side Sewer—The portion of a pipe connecting a private property to the public sewer system that is on the private property

ABBREVIATIONS

B/C—Benefit/cost

CCTV—Closed circuit television

cfs—Cubic feet per second

CMP—Corrugated metal pipe

CSI—Conveyance System Improvements

CSU—Concrete segments, unbolted

CT—Clay tile

E&P Subcommittee—Engineering and Planning Subcommittee

gpm—Gallons per minute

I/I—Infiltration and Inflow

IMAP—Interactive Mapping System

KCDNRP—King County Department of Natural Resources and Parks

MG—Million gallons

mgd—Million gallons per day

MWPAAC—Metropolitan Water Pollution Abatement Advisory Committee

NGPA— Native Growth Protection Area

NGPE— Native Growth Protection Easement

NRCS—Natural Resource Conservation Service

PVC—Polyvinyl chloride

ROE—Right of entry

RWSP—Regional Wastewater Services Plan

SSES—Sanitary sewer evaluation survey

WDFW—Washington Department of Fish and Wildlife

WDNR—Washington Department of Natural Resources

WTD—Wastewater Treatment Division

EXECUTIVE SUMMARY

BACKGROUND

The *Initial Infiltration and Inflow Reduction Project Alternatives Analysis* report presents recommendations for projects to reduce infiltration and inflow (I/I) in portions of King County's regional wastewater conveyance system. Reducing I/I, which consists of stormwater and groundwater entering a sanitary sewer system from various sources, makes more capacity available for sewage in the county's wastewater system. This increased capacity helps prevent overflows and reduce the need for capital projects to add system capacity. King County is engaged in a long-term program to reduce I/I when cost-effective to do so, and the projects outlined in this alternatives analysis represent an early test of the effectiveness of I/I reduction measures over a large area.

Previously, King County conducted a six-year study on I/I control, which included pilot-testing in several small areas of the county and a detailed benefit/cost analysis. The benefit/cost analysis outlined a general process for assessing whether the cost of I/I reduction measures can be recaptured through savings associated with elimination or reduction in size of capital projects that otherwise would be needed to increase system capacity. Specifically, the process looks at potential savings in the cost of projects planned under King County's Conveyance System Improvement (CSI) Program. The 2007 update to the CSI Program identifies 33 needed projects, assuming no broad I/I reduction across the service region. Successful I/I reduction projects may eliminate the need for an identified CSI project, reduce the required size of the project, or allow for delay in the implementation of the project. Any of these results can lead to cost savings in the CSI Program.

The initial I/I reduction projects fulfill the key components of the Executive's recommendation based on the six-year study:

- Select, implement, and evaluate two or three initial I/I reduction projects to test the cost-effectiveness of I/I reduction on a larger scale than the pilot projects.
- After completion of the initial projects, make recommendations to the King County Council regarding long-term I/I reduction and control.

Mini-Basin—A drainage basin (geographic area encompassing all portions of the wastewater collection system draining to a single point) defined by King County's Regional I/I/ Control Program in order to establish manageable target areas for sewer system evaluation and rehabilitation. Mini-basins typically include about 20,000 feet of sewer lines.

PROJECT DESCRIPTION

Areas Investigated and Affected CSI Projects

Four project areas for the Initial I/I Reduction project were selected in October 2006 by the Engineering and Planning (E&P) Subcommittee of the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC), which represents all the jurisdictions served by the King County regional wastewater system. The four project areas—Eastgate, Issaquah, Renton and Skyway—were chosen from a list of nine that were originally identified as potentially cost-effective in the November 2005 *Benefit/Cost Analysis Report*. Each project area consists of one or more "mini-basins," which were previously delineated by King County's Regional I/I Control Program. Figure ES-1 shows the locations of the four project areas.

The following CSI projects could be affected by I/I reduction in each project area:

- Eastgate Project Area (City of Bellevue)—The 2.33-million-gallon (MG) Eastgate Storage project

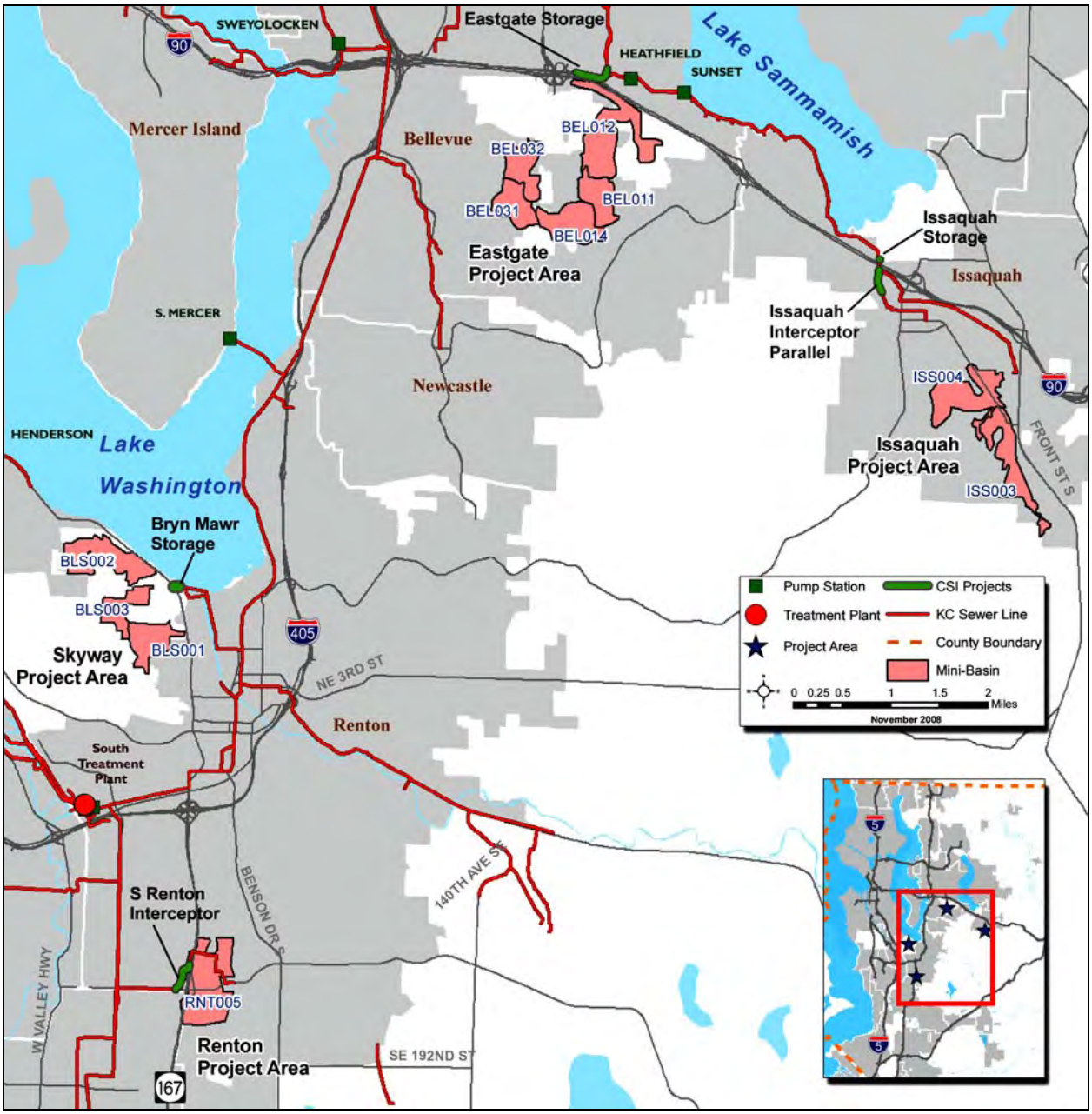


Figure ES-1. Project Areas and Mini-Basins Evaluated for Initial I/I Reduction Project

- Issaquah Project Area:
  - The 2.33-MG Eastgate Storage project
  - The 1.77-MG Issaquah Storage project
  - The 1.72-million-gallon-per-day (mgd) Issaquah Interceptor Parallel
- Renton Project Area—The South Renton Interceptor project
- Skyway Project Area—The 0.27-MG Bryn Mawr Storage project

Initial Evaluations Performed

For each mini-basin, the county has performed computer modeling to estimate the amount of I/I that would enter the sewer system within the mini-basin for a 20-year peak-flow event. These estimates are used as the baseline I/I flow for each mini-basin in this alternatives analysis. The evaluation of alternatives involved estimating how much each mini-basin's 20-year peak I/I flow could be reduced by implementing each alternative.

Investigations were conducted to assess the sewer system and surrounding environment for each project area. The sewer system evaluation survey (SSES) consisted of video inspections of sewers, smoke-testing, new flow monitoring, and limited dye testing and field visits to evaluate the condition of the existing sewer system and the level of flows attributable to I/I. The environmental assessment used field visits and review of previous studies to determine whether I/I reduction projects would have the potential for negative impacts on groundwater, surface water, geotechnical features or local drainage systems.

Alternatives Analysis Approach

Following the initial evaluations of the sewer system and surrounding environment, the analysis of alternatives for the initial I/I reduction project consisted of the following steps:

- Rehabilitation unit costs were developed based on field conditions in each mini-basin. Each property in the project areas was assigned a rehabilitation difficulty rating (easy, medium or difficult) and associated unit cost for rehabilitation.
- I/I quantities were uniformly apportioned across each mini-basin and were equated to an average I/I per property in the mini-basin.
- Rehabilitation alternatives were developed that consisted of rehabilitation in single or multiple mini-basins, including alternatives that combine rehabilitation in the Issaquah and Eastgate project areas where there are mutual benefits in the reduction of regional downstream conveyance needs. The alternatives considered a range of I/I reduction effectiveness from 60 to 75 percent.
- Alternatives were rated using criteria developed by the E&P Subcommittee. To be considered cost-effective under these criteria, an I/I reduction project must reduce, delay or eliminate a recommended downstream CSI project; and the associated cost savings must equal or exceed the cost of the I/I reduction project. Rehabilitation scenarios found to be cost-effective were evaluated in greater detail to identify preferred alternatives.

GENERAL FINDINGS

The following findings were made based on the analysis of project areas:

- The SSES revealed a moderate number of defects in mains, laterals and side sewers in each project area. I/I appears to be fairly uniformly allocated across each project area.
- The SSES generally confirmed the conventional wisdom that laterals and side sewers represent the major source of I/I in a system.
- New flow monitoring data collected in each project area during the 2007/2008 wet season was generally consistent with previous data; and both the new and old data suggest that a large percentage of I/I in the project areas originates from private property.
- The only significant difference between new and previous flow monitoring data was in the Renton project area, where the new data showed lower peak I/I levels. The SSES, including smoke tests and CCTV inspections, failed to identify the source of peak inflows in this

project area. However, several manholes in a wetland within the project area were identified as becoming submerged during heavy rainfall events; water entering the system through these manholes is a likely significant source of inflow.

- Although geotechnical, groundwater and environmental conditions were found to vary widely across the project areas, no conditions were found that pose significant issues for potential rehabilitation projects.
- It is likely that instances of drainage-related problems will result from I/I reduction improvements. In order to address drainage complaints that could be caused by any initial I/I reduction projects, it is recommended that a portion of the project construction cost be allocated to fixing any associated drainage problems that occur following rehabilitation.
- For some of the basins, rehabilitation unit costs, which were developed based on actual field conditions in each project area, are substantially higher than previously estimated in King County's 2005 benefit/cost analysis because of the degree of difficulty in accessing mains, laterals and side sewers. This was particularly true for portions of the Eastgate and Issaquah project areas. Table ES-1 summarizes the unit costs developed for this project.
- A general finding of the analysis was that basins with an I/I allocation of less than 3 gallons per minute (gpm) per property were not good candidates for cost-effective removal of I/I because achieving the total targeted I/I reduction in those basins would require rehabilitation of too many properties.

ALTERNATIVES ANALYSIS

Mini-Basin Scenarios

Mini-basin rehabilitation scenarios were developed consisting of varying combinations of rehabilitation of side sewers and laterals, and direct disconnections of roof drains and yard drains from the sewer system. The following are typical mini-basin rehabilitation scenarios:

- Rehabilitate laterals and side sewers on 50 percent of service parcels; rehabilitate only side sewers on 45 percent of service parcels; and implement direct disconnects on 4 percent of service parcels (this scenario, which does not distinguish between easy, medium and difficult parcels, was defined as "Technique 4" in the 2005 *Benefit/Cost Analysis Report* and was the recommended scenario in that report).
- Rehabilitate laterals and side sewers on all service parcels.
- Rehabilitate laterals and side sewers on 95 percent of service parcels.
- Rehabilitate laterals and side sewers on all easy and medium service parcels.

Variations of these scenarios were developed for each mini-basin. The goal was to establish and evaluate a reasonable range of I/I reduction approaches in order to find a suitable balance between construction cost and I/I reduction. Where smoke testing identified direct inflow sources, direct disconnects to eliminate the inflow sources are included in the rehabilitation scenarios. In all, 46 rehabilitation scenarios were developed and evaluated for nine mini-basins. Based on the evaluation, 20 scenarios in seven mini-basis were selected to create initial I/I reduction alternatives.

I/I Reduction Alternatives

Mini-basin rehabilitation scenarios selected for use in alternatives were evaluated individually or in combinations, based on the downstream CSI project that could be affected by their implementation. Twenty-seven alternatives were developed from the selected scenarios.

The alternatives and their estimated impacts on I/I were provided to King County's modeling group to assess the potential for reducing or eliminating downstream CSI projects due to the reduced I/I flows. Cost savings associated with CSI project reduction allowed by each initial I/I reduction alternative were estimated for comparison to the construction costs for the alternative. Alternatives with a benefit/cost ratio of 1.0 or greater may be recommended for implementation as initial I/I reduction projects.

RECOMMENDATIONS

The alternatives analysis indicated that cost-effective rehabilitation is feasible in only four mini-basins. Cost-effective rehabilitation in all other mini-basins is limited due to a low I/I allocation per property (requiring a greater number of properties to be rehabilitated) and high unit costs for rehabilitation because of difficult field conditions. Two I/I reduction alternatives, consisting of rehabilitation in three of the four feasible mini-basins, are recommended for implementation:

- **Eastgate/Issaquah Alternative BEL/ISS-B (see Figure ES-2)**—This alternative includes rehabilitation of laterals and side sewers in Eastgate Mini-Basin BEL031 and Issaquah Mini-Basin ISS003. Components include the following:
  - 82 easy and 25 medium lateral and side sewer replacements in Mini-Basin BEL031 (50 percent of 213 properties in the mini-basin).
  - 37 easy and 76 medium lateral and side sewer replacements in Mini-Basin ISS003 (85 percent of 133 properties in the mini-basin).
  - The combined estimated range of I/I reduction for the two mini-basins is 1.04 mgd (75-percent reduction effectiveness) to 0.85 mgd (60-percent reduction effectiveness).
  - Reduction in the Eastgate Storage requirement is between 320,000 gallons (75-percent reduction effectiveness) and 260,000 gallons (60-percent reduction effectiveness).

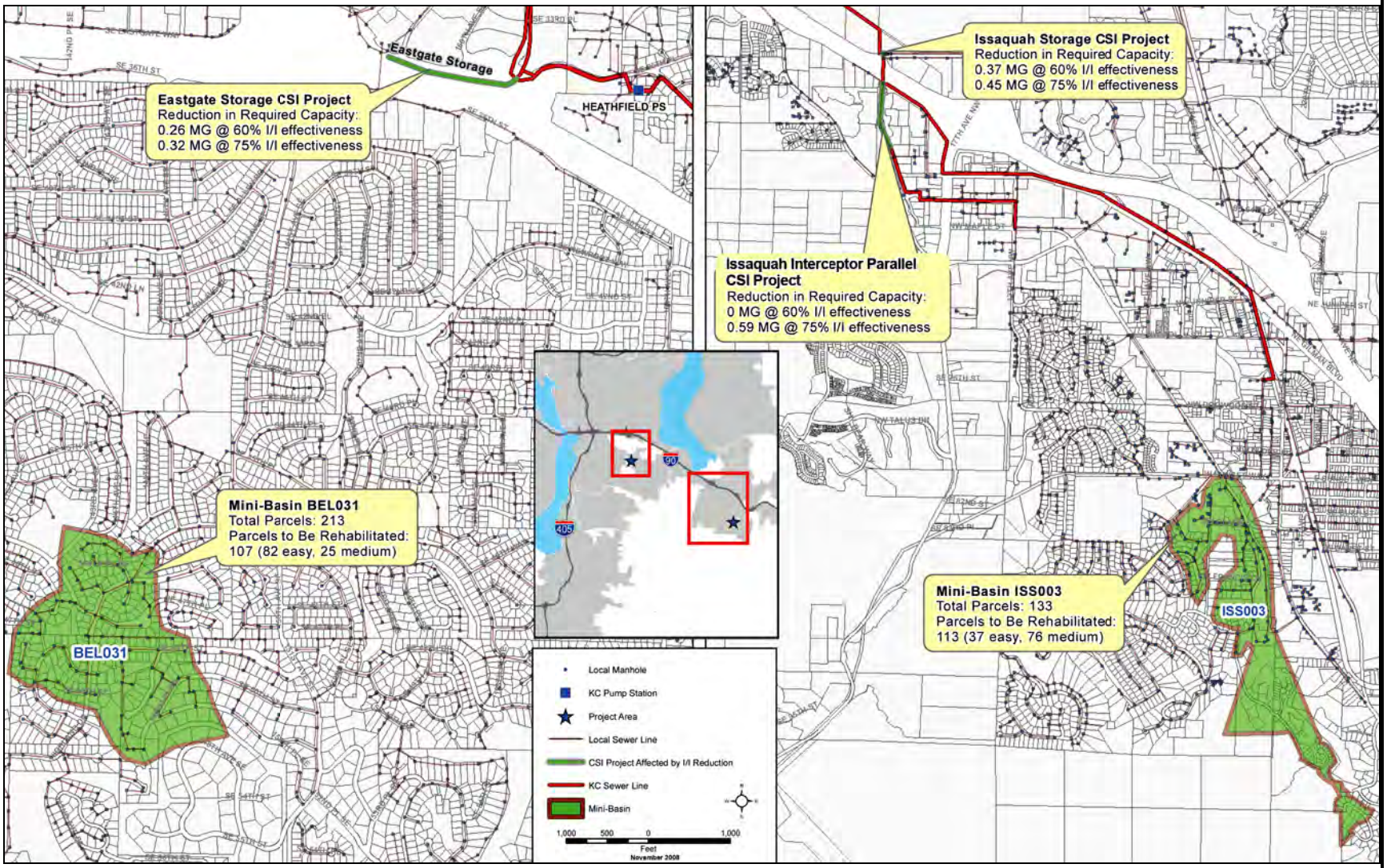


Figure ES-2. Eastgate/Issaquah Alternative BEL/ISS-B

  - Reduction in the Issaquah Storage requirement is between 450,000 gallons (75-percent reduction effectiveness) and 370,000 gallons (60-percent reduction effectiveness).
  - Reduction in the downstream CSI project costs is between $6.37 million (75-percent reduction effectiveness) and $5.12 million (60-percent reduction effectiveness).
  - The estimated project cost for the I/I rehabilitation is $5.23 million. Although this project is marginally below the cost-effectiveness threshold of 1.0 if only 60-percent I/I removal is achieved, past similar projects have shown I/I removal rates on average of 77 percent. The cost estimate for I/I reduction is also conservative, so the risk is minimized that the project would not achieve cost-effectiveness.

- **Skyway Alternative BLS-F (see Figure ES-3)**—This alternative includes rehabilitation of laterals and side sewers in Skyway Mini-Basin BLS002. Components include the following:
  - 292 easy and 51 medium lateral and side sewer replacements (89 percent of the 386 properties in the mini-basin).
  - The estimated range of I/I reduction is 2.29 mgd (75-percent reduction effectiveness) to 1.88 mgd (60-percent reduction effectiveness).
  - The rehabilitation eliminates the need for the 270,000-gallon Bryn Mawr Storage project, and the associated $5.37 million total project cost.
  - The estimated project cost for the I/I rehabilitation is $5.63 million, requiring cost-sharing of $260,000 by the Skyway Water and Sewer District to make the project cost-effective.
  - The Skyway Water and Sewer District wants to add rehabilitation of mains and manholes to this project. The District has agreed to pay for the additional construction cost to add these components.

Estimates and project details will be refined through the predesign process in 2009 and the final design in 2010. The predesign will identify exact parcels for rehabilitation and confirm the preferred construction method. During final design, contract documents will be prepared, rights of entry will be acquired, and the public participation program will be carried out. Construction of the projects will take place in 2011 and 2012. Post-project evaluation and the King County Executive's submittal of recommendations for future work to the King County Council will occur in 2013.

For the Renton project area, flow monitoring performed for this alternatives analysis did not indicate the level of I/I that had previously been measured or predicted by modeling. It is possible that Washington State Department of Transportation construction on the SR-167 on-ramp resulted in changes to the surface water drainage patterns, diverting surface water away from the sewer line in the wetland area. Given the current levels of measured I/I in the mini-basin, it does not appear that rehabilitation in the mini-basin will meet the cost-effectiveness criteria established for this project. At the April 16, 2008 E&P Subcommittee meeting, a decision was made to remove the Renton project area from further consideration of large-scale rehabilitation under the Initial I/I Reduction project.

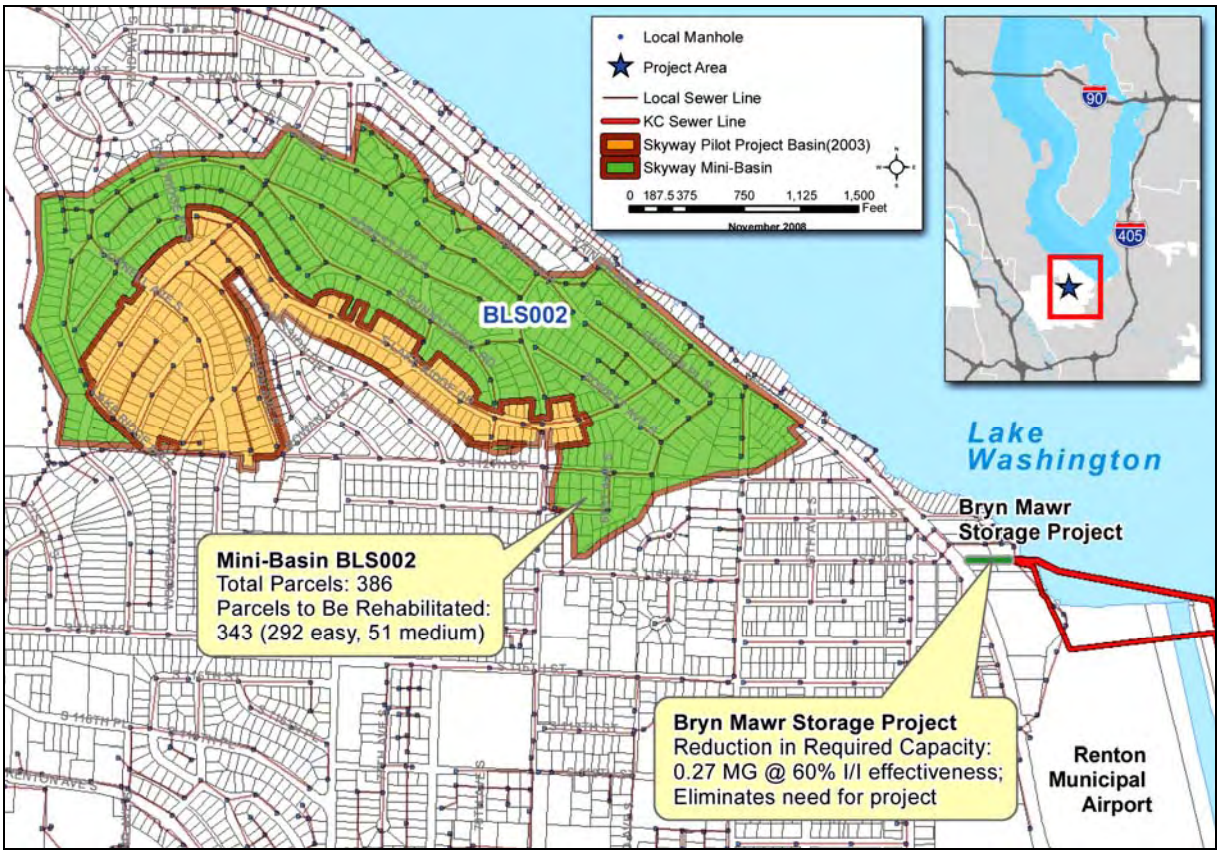


Figure ES-3. Skyway Alternative BLS-F

CHAPTER 1.
PROJECT BACKGROUND AND STUDY AREAS

This alternatives analysis report presents recommendations for projects to reduce infiltration and inflow (I/I) in portions of King County's regional wastewater conveyance system. It describes the analysis performed to identify and evaluate potential projects, provides estimates of project cost and benefit, and presents considerations that must be addressed in moving forward to design of the recommended projects.

1.1 PLANNING BACKGROUND

1.1.1 Regional I/I Control Program

The King County Wastewater Treatment Division (WTD) serves 34 local cities and sewer districts in the county's regional service area. WTD must provide adequate capacity in its system to convey and treat wastewater flows sent by the cities and districts through their collection systems. With the exception of portions of the City of Seattle that have combined sewers (designed to convey wastewater and stormwater in the same pipes), sewers in the regional wastewater system are designed to convey only wastewater. However, many of these "separated" sewers also convey clean groundwater and stormwater that enter through leaky pipes, improper storm drain connections, and other means.

This clean water consists of infiltration, which is groundwater that enters a wastewater conveyance system through cracks or other defects in the buried infrastructure, and inflow, which is rainwater runoff that enters the system through manholes, roof drains or other surface openings connecting to the system. The combined contribution of infiltration and inflow (I/I) takes up capacity that could otherwise be used for wastewater alone and generates the need to build added capacity in pipelines, treatment plants and other facilities. This need for added capacity results in higher capital and operating costs for the regional system that are borne by ratepayers in all local jurisdictions. Reducing I/I in the system has the potential to lower the risk of sanitary sewer overflows and decrease the costs of conveying and treating wastewater.

The King County Regional I/I Control Program was created in 1999 as part of the Regional Wastewater Services Plan (RWSP). The purpose of the program is to reduce I/I in the county's wastewater conveyance system when it is cost-effective to do so. The county worked with local agencies to conduct a six-year I/I control study beginning in 2000. The study included pilot testing and a benefit/cost analysis of potential I/I control approaches, and culminated with an Executive's recommendation for regional I/I control. The key thrusts of the Executive's recommendation are twofold (King County, 2005a):

- King County and the local agencies would select, implement, and evaluate two or three "initial" I/I reduction projects to test the cost-effectiveness and feasibility of I/I reduction on a larger scale than the pilot projects.
- After completion of the initial projects, recommendations would be made to the King County Council regarding long-term I/I reduction and control.

The Initial Infiltration and Inflow Reduction Project is the implementation of the Executive's recommendation. Figure 1-1 shows the milestones included in the project. The project's scope includes an analysis of alternatives for four candidate I/I project areas and final design and construction for up to three initial I/I reduction projects.

Figure 1-1. Projected I/I Program Milestones

The recommended projects will consist of replacing or rehabilitating sanitary sewer collection system facilities in local agency systems to remove groundwater and stormwater sources from the sewer system. Work on private property might consist of rehabilitation or replacement of side sewers (the private-property portion of a pipe connecting the property to the public sewer system). Work in the public right-of-way would generally include the rehabilitation or replacement of main lines, service connections to the main line, laterals (the public-property portion of a pipe connecting a private property to the public sewer system), and manholes. Construction techniques could include pipe bursting, pipe replacement, pipe lining, manhole rehabilitation, manhole replacement, cleanout installations, and disconnection or repair of direct-connection inflow sources.

1.1.2 Conveyance System Improvement Program

King County's Conveyance System Improvement (CSI) Program outlines needed capital improvements to the county-owned regional conveyance system to provide adequate capacity for 20-year peak wastewater flows through 2050. The process for identifying capacity needs consisted of four main steps:

- Estimating current 20-year peak flow demands on the regional conveyance system to establish a baseline that represents how the system currently performs under peak flow conditions.
- Projecting 20-year peak flows by decade through 2050 for the regional conveyance system using population and employment growth projections.
- Using a hydraulic model of the conveyance system to identify capacity constraints based on when the 20-year peak flows will exceed the capacity of existing regional conveyance facilities.
- Verifying and adjusting identified growth assumptions and capacity constraints using updated information from component agencies.

The most recent update to the CSI Program (King County, 2007a) presents 33 project recommendations assuming no broad I/I reduction across the service region. Successful I/I reduction projects may eliminate the need for an identified CSI project, reduce the required size of the project, or allow for delay in the implementation of the project. Any of these results can lead to cost savings in the CSI Program.

1.1.3 Benefit/Cost Analysis

King County's November 2005 *Benefit/Cost Analysis Report; Regional Infiltration and Inflow Control Program* compared the estimated costs of constructing conveyance system improvement projects with the estimated costs of I/I reduction projects. The report drew upon pilot test results and discussions with local agencies to establish assumptions for estimating rehabilitation costs for I/I rehabilitation projects and the expected amount of I/I reduction. Among these was the assumption that unit costs could be established

for components of I/I rehabilitation work that would be uniform across King County. These unit costs included the following:

- $3,900 for rehabilitation of a lateral on any one property
- $3,500 for rehabilitation of a side sewer on any one property
- $6,800 for rehabilitation of a lateral and side sewer on any one property
- $3,000 for disconnection of any direct source of inflow to the sewer system (these projects are called “direct disconnects”).

The benefit/cost report also presented assumptions for the amount of I/I in a sewer basin that could be removed by a given set of I/I rehabilitation projects. It defined four techniques for I/I reduction in a basin, and presented the following conservative I/I reduction estimates for each:

- Technique 1—Perform direct disconnects on 4 percent of basin parcels: 10-percent I/I reduction
- Technique 2—Rehabilitate 95 percent of sewer mains, manholes, laterals and side sewers; perform direct disconnects on 4 percent of basin parcels: 80-percent I/I reduction
- Technique 3—Rehabilitate 50 percent of sewer mains, manholes and laterals; perform direct disconnects on 4 percent of basin parcels: 40-percent I/I reduction
- Technique 4—Rehabilitate 50 percent of laterals and side sewers and 45 percent of side sewers only; perform direct disconnects on 4 percent of basin parcels: 60-percent I/I reduction

The report identified Technique 4 as its preferred approach for I/I reduction projects based on pilot project results, which suggested that it provides the most cost-effective I/I removal. The benefit/cost report assumptions were used as a starting point for this alternatives analysis, but were modified as appropriate based on new information collected as part of this project.

1.2 PROJECT GOALS

The overall objective of the initial I/I reduction projects is to remove enough I/I to downsize, delay or eliminate the need for downstream conveyance improvement projects, resulting in a net savings to the county. The benefit/cost report outlined specific I/I reduction targets for flows to nine proposed CSI projects. Four of those were selected for evaluation in the initial I/I reduction project. Table 1-1 summarizes the benefit/cost report’s estimates for the four projects. These results established a starting point for the analysis of alternatives for initial I/I reduction. The costs and I/I reduction targets were updated as part of the analysis to select initial projects. The results of the initial projects will be used to inform further recommendations to the King County Council regarding long-term I/I reduction, including applicable changes to policy or code.

Much is yet to be learned about the feasibility and cost-effectiveness of I/I reduction on a large scale, therefore the Executive’s recommendation called for implementation of two or three initial demonstration projects to gain more information prior to the county launching a full I/I reduction program. If I/I reduction on a large scale proves to be cost-effective and feasible, a recommendation would be made that it be considered as a project alternative during planning and pre-design for any conveyance improvement project. For future work, wherever I/I reduction is less expensive than the otherwise needed conveyance project, WTD would fund the I/I project, including work in local agency systems and on private property.

TABLE 1-1.
ORIGINAL TARGETS AND ESTIMATED BENEFITS AND COSTS
FOR INITIAL I/I REDUCTION PROJECT

Affected CSI Project	Intended Benefit	I/I Reduction Target to Achieve Intended Benefit	I/I Reduction Project Cost	CSI Project Cost Savings	Benefit / Cost Ratio
Eastgate Storage & Trunk	Eliminate the need for Eastgate Tube Storage	3.55 million gallons/day (mgd)	$14.46 million	$16.63 million	1.2
Issaquah 2 Trunk	Eliminate the need for Issaquah 2 Trunk upgrades; reduce required size for Issaquah Tube Storage	1.05 mgd	$3.96 million	$5.77 million	1.5
South Renton Interceptor	Eliminate the need for South Renton Interceptor upgrade	0.81 mgd	$2.22 million	$7.27 million	3.3
Bryn Mawr Storage	Reduce the size of the Bryn Mawr Storage	2.04 mgd	$6.02 million	$8.51 million	1.4

Source: King County, 2005b.

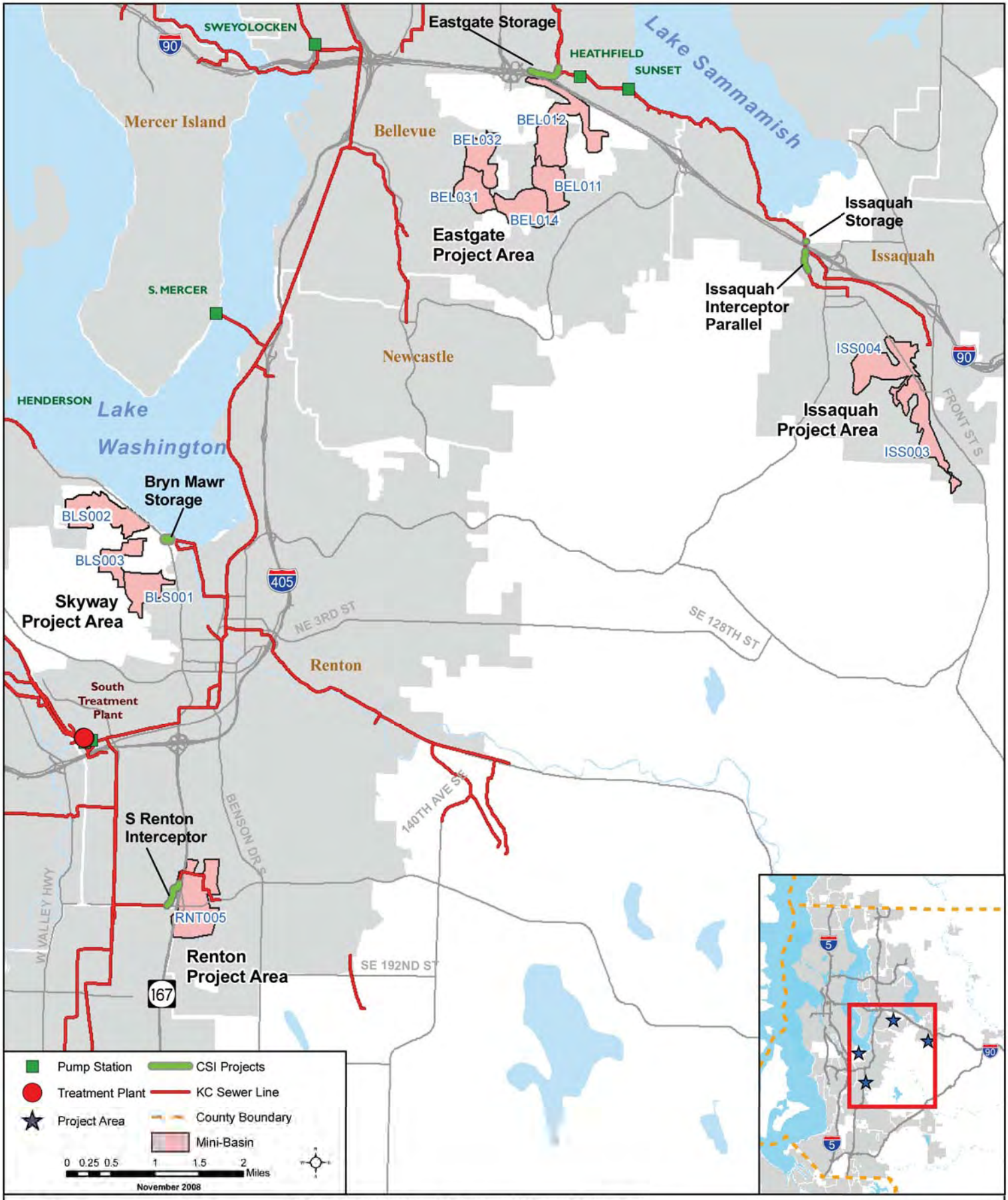
Once completed, the initial I/I reduction projects are to be evaluated to determine whether they were able to reduce I/I levels enough to delay, downsize or eliminate the need for downstream CSI projects, and whether I/I reduction on this scale is cost-effective.

The following are the goals of the Initial I/I Reduction Project:

- Conduct an I/I reduction alternatives analysis for four project areas: Eastgate, Issaquah, Renton and Skyway.
- Select and implement up to three initial I/I reduction projects in 2010-12 to test the cost-effectiveness of I/I reduction on a scale large enough to potentially reduce the need for downstream conveyance or storage facility capacity. The total construction cost budget for all projects combined will not exceed $8.5 million.
- Analyze the results of these initial projects and make recommendations to the King County Council regarding long-term I/I reduction and control, including applicable changes to policy or code.

1.3 DESCRIPTION OF PROJECT AREAS

Four candidate project areas for the Initial I/I Reduction project were selected in October 2006 by the Engineering and Planning (E&P) Subcommittee of the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC), which represents all the jurisdictions served by the King County regional system. The four project areas—Eastgate, Issaquah, Renton and Skyway—were chosen from a list of nine that were originally identified as potentially cost-effective in the November 2005 *Benefit/Cost Analysis Report*. The selection was based on a comparative evaluation using criteria established by the MWPAAC. Figure 1-2 shows the locations of the four project areas.



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\lwtd\projects\ii_initial_Projec\project \TechReport\Overview_proj_area_locations.mxd - peter keum
Data Source: King County

Figure 1 - 2

Project Area Locations

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

Each project area consists of one or more "mini-basins," which were previously delineated by King County's Regional I/I Control Program. For each mini-basin, the county has performed computer modeling to estimate the amount of I/I that would enter the sewer system within the mini-basin for a 20-year peak-flow event. These estimates are used as the baseline I/I flow for each mini-basin in this alternatives analysis. The evaluation of alternatives involved estimating how much each mini-basin's 20-year peak I/I flow could be reduced by implementing each alternative.

The following sections provide additional information about each project area and its component mini-basins.

1.3.1 Eastgate

Physical Area

The Eastgate project area is in the City of Bellevue, south of the I-90 corridor and following 148th/150th Avenue SE through the Eastgate and Hilltop neighborhoods (see Figure 1-3). The project area consists of five mini-basins:

- Mini-Basin BEL011—259 Parcels, 97 acres
- Mini-Basin BEL012—441 Parcels, 221 acres
- Mini-Basin BEL014—225 Parcels, 131 acres
- Mini-Basin BEL031—213 Parcels, 93 acres
- Mini-Basin BEL032—223 Parcels, 94 acres

The mini-basins in this project area vary in size but share similar physical attributes: steep topography, winding rights of way, and numerous areas of heavy forest separating adjacent rights of way.

Sewer System

The Eastgate project area is served entirely by gravity sewers, consisting primarily of cement concrete pipe, with isolated pockets of polyvinyl chloride (PVC) side sewers. Based on the results of King County modeling, the 20-year peak I/I flow contribution to Eastgate mini-basins is as follows:

- Mini-Basin BEL011—0.78 million gallons per day (mgd)
- Mini-Basin BEL012—1.35 mgd
- Mini-Basin BEL014—0.56 mgd
- Mini-Basin BEL031—1.31 mgd
- Mini-Basin BEL032—0.72 mgd

Flow monitoring before and during the efforts included in this report did not reveal any need for modifications to the modeling results, so these values are used in calculating potential downstream impacts of I/I reduction in the Eastgate project area.

Affected CSI Projects

The CSI Program capital project downstream of this project area that is expected to be affected by I/I reduction in the project area is the 2.33-million-gallon (MG) Eastgate Storage project. Flows would have to be reduced by 5 mgd to allow for elimination of the facility.

1.3.2 Issaquah

Physical Area

The Issaquah project area is in the west-central portion of the City of Issaquah (see Figure 1-4). The project area consists of two mini-basins:

- Mini-Basin ISS003—133 Parcels, 81 acres
- Mini-Basin ISS004—293 Parcels, 136 acres

Mini-Basin ISS003 extends east from the eastern side of Squak Mountain to about Issaquah Creek. Mini-Basin ISS004 extends east from the eastern side of Squak Mountain to about Newport Way SE.

The project area consists of single-family residences and multi-family apartments and condos. There is no commercial development. Most properties within the project area are on hillside developments. Storm drainage infrastructure is present.

Sewer System

The Issaquah project area is served entirely by gravity sewers. Wastewater flows are conveyed generally east and north. Older neighborhoods in the project area are served by concrete sewers, and newer neighborhoods are served by PVC sewers. Based on the results of King County modeling, the 20-year peak I/I flow contribution is as follows:

- Mini-Basin ISS003—0.65 mgd
- Mini-Basin ISS004—0.81 mgd

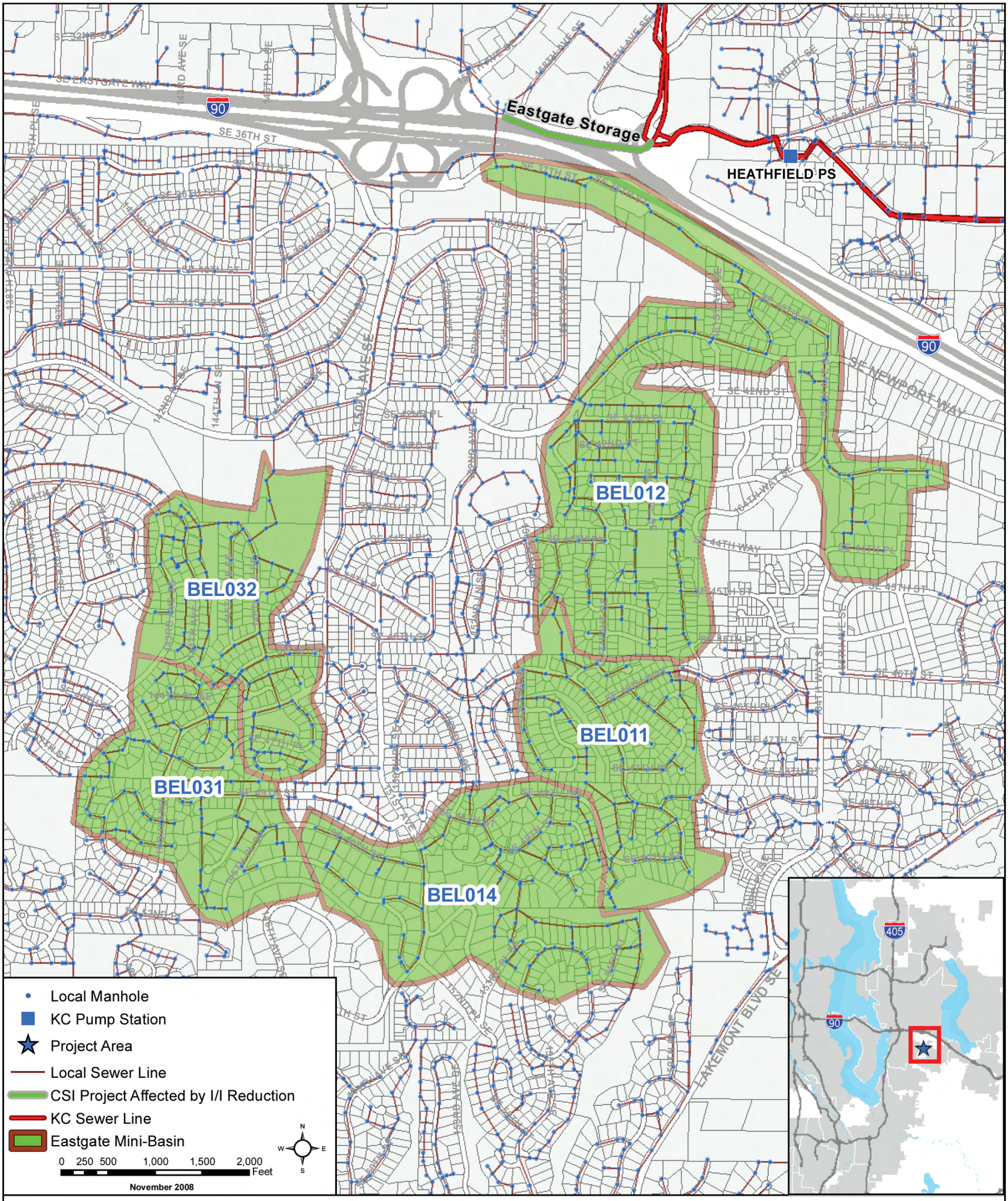
Flow monitoring before and during the efforts included in this report did not reveal any need for modifications to the modeling results, so these values are used in calculating potential downstream impacts of I/I reduction in the Eastgate project area.

Affected CSI Projects

The following CSI Program capital projects downstream of this project area have the potential to be impacted by the amount of I/I in the system:

- The 2.33-MG Eastgate Storage
- The 1.77-MG Issaquah Storage
- The 26.6-mgd Sunset/Heathfield Pump Station Replacement
- The 1.72-mgd Issaquah Interceptor Parallel

The Sunset and Heathfield pump stations will be sized to accommodate the peak flows that can reach the facilities. I/I reduction upstream of these pump stations will affect the sizing requirements for the Issaquah Storage and the Issaquah Interceptor Parallel, but will not significantly reduce the required pump station capacity requirements. Therefore, any slight capacity reduction in the Sunset/Heathfield Pump Station Replacement determined by this analysis will not be considered in the analysis of potential I/I projects in this area.



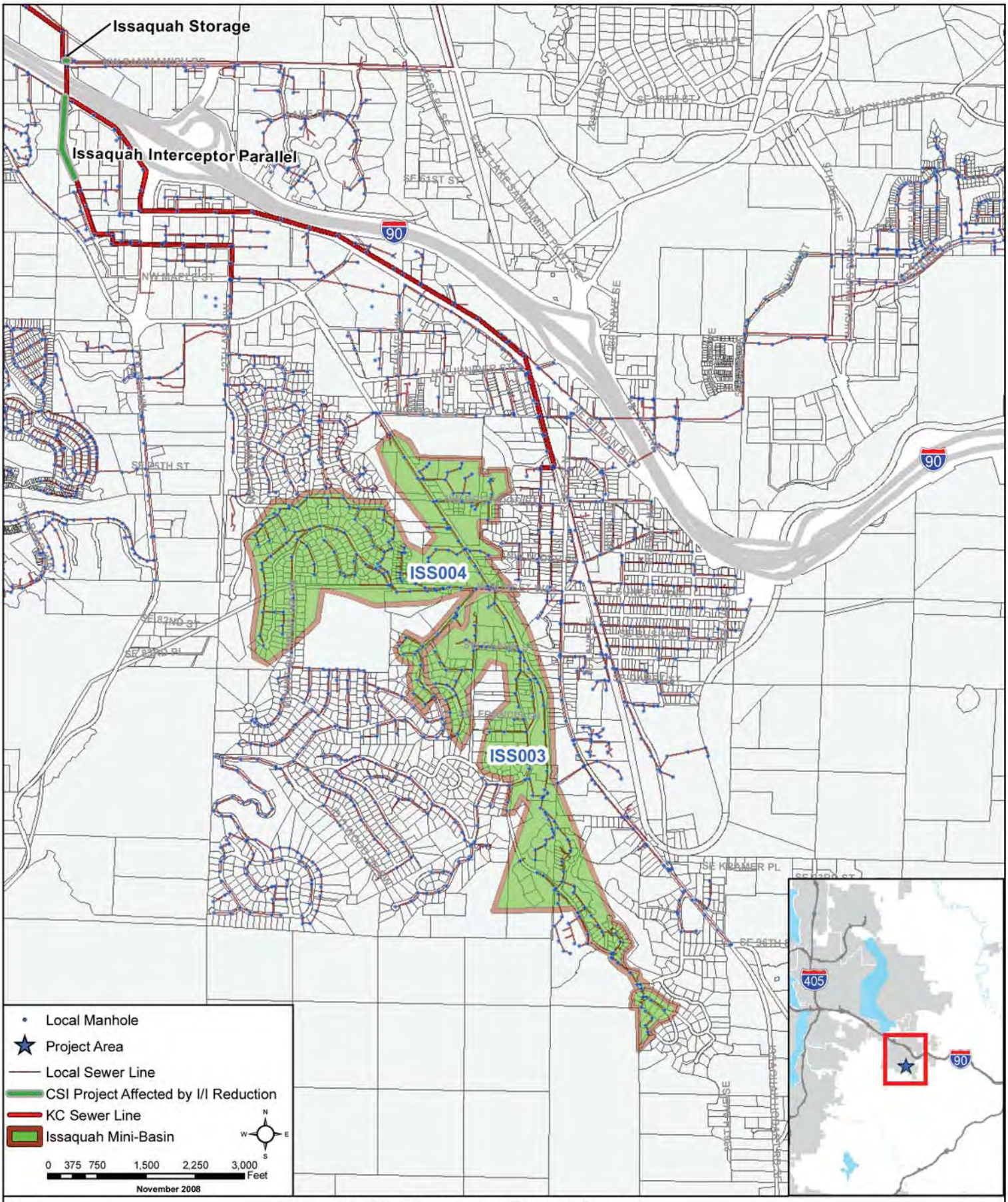
King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Eastgate_ProjectArea.mxd - peter keum
Data Source: King County

Figure 1 - 3

Eastgate Project Area

Initial Infiltration and Inflow Reduction Alternatives Analysis Report



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Issaquah_ProjectArea.mxd - peter keum
Data Source: King County

Figure 1 - 4

Issaquah Project Area

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

1.3.3 Renton

Physical Area

The Renton project area lies at the foot of the east slopes of the Green River valley (see Figure 1-5). The project area consists of one mini-basin, RNT005, which is east of SR-167, roughly between about South 36th Street and South 47th Street. The 2005 *Benefit/Cost Analysis Report* identified a second mini-basin in this project area as potentially cost-effective for I/I reduction—Mini-Basin SOO021; however, this mini-basin was excluded from the analysis because it was determined that only slight I/I reduction in the mini-basin is feasible and because it includes many commercial properties, which would not easily be rehabilitated. Evaluation for this project focused on the western portion of the Renton project area, where a north-south sewer line crosses a wetland between SR-167 and Valley Medical Center.

Mini-Basin RNT005 includes about 185 property parcels, including multi-family development, undeveloped land, single-family housing, the Valley Medical Center and its appurtenant clinics, and small businesses. Approximately 20 percent of the 111-acre mini-basin is single-family housing and 50 percent is multi-family housing. The hospital is currently undergoing an expansion.

Sewer System

The Renton project area is served entirely by gravity sewers; there are no wastewater pump stations. Wastewater flows generally southeast to northwest. According to modeling performed for the I/I Control Program, the 20-year peak I/I contribution to sewers in this project area is 7 mgd.

Affected CSI Projects

The CSI Program capital project downstream of this project area that is expected to be affected by I/I reduction in the project area is the South Renton Interceptor project, which will be a parallel pipeline constructed to increase capacity in the regional sewer system

1.3.4 Skyway

Physical Area

The Skyway project area is immediately west of the southern end of Lake Washington above Rainier Avenue South (see Figure 1-6). The project area consists of three mini-basins:

- Mini-Basin BLS001—391 Parcels, 93 acres
- Mini-Basin BLS002—386 Parcels, 157 acres
- Mini-Basin BLS003—232 Parcels, 63 acres

The 2005 *Benefit/Cost Analysis Report* did not identify Mini-Basin BLS002 as a potential candidate for I/I reduction. This mini-basin was part of the I/I pilot project performed in 2003, which replaced sewer mains and manholes and rehabilitated approximately 175 laterals and side sewers. Comprehensive flow monitoring of the mini-basin was not performed following the pilot project, so the amount of I/I remaining in the mini-basin following rehabilitation was undefined. The mini-basin was added for this analysis after flow monitoring performed as part of this project revealed high levels of I/I remaining in the portions of the mini-basin that were not rehabilitated during the pilot project.

Development within each of the three mini-basins is predominantly single-family residential, constructed in the late 1950s and early 1960s. Mini-Basin BLS002 includes additional properties not included in this analysis because they were rehabilitated as part of the pilot project.

Sewer System

The Skyway project area is served entirely by gravity sewers. Wastewater generally flows from south to north in Mini-Basins BLS001 and BLS003 and from east to west in Mini-Basin BLS002. The sewer collection system in the three mini-basins conveys flow to Rainer Avenue South, where the system discharges to King County's regional sewer system. Sewer mains, laterals and side sewers are constructed primarily of concrete pipe, which was installed in the 1950s by the Bryn Mawr Sewer District, which provided sewer service to the area at the time.

According to the Skyway Water and Sewer District, several portions of the collection system have experienced capacity problems during significant rain events. Overflows and sewer backups have occurred in several locations; including the northeast portion of Mini-Basin BLS003 and the downstream portion of Mini-Basin BLS002 near Rainer Avenue South.

Based on King County modeling, the 20-year peak I/I contributions in this project area are as follows:

- Mini-Basin BLS001—0.97 mgd
- Mini-Basin BLS002—3.00 mgd (this is the quantity attributed to the portion of the mini-basin not rehabilitated in the pilot project; based on post-pilot-project monitoring, the remaining I/I within the rehabilitated area is estimated to be an additional 0.39 mgd)
- Mini-Basin BLS003—1.68 mgd

Flow monitoring before and during the efforts included in this report did not reveal any need for modifications to the modeling results, so this value is used in calculating potential downstream impacts of I/I reduction in the Skyway project area.

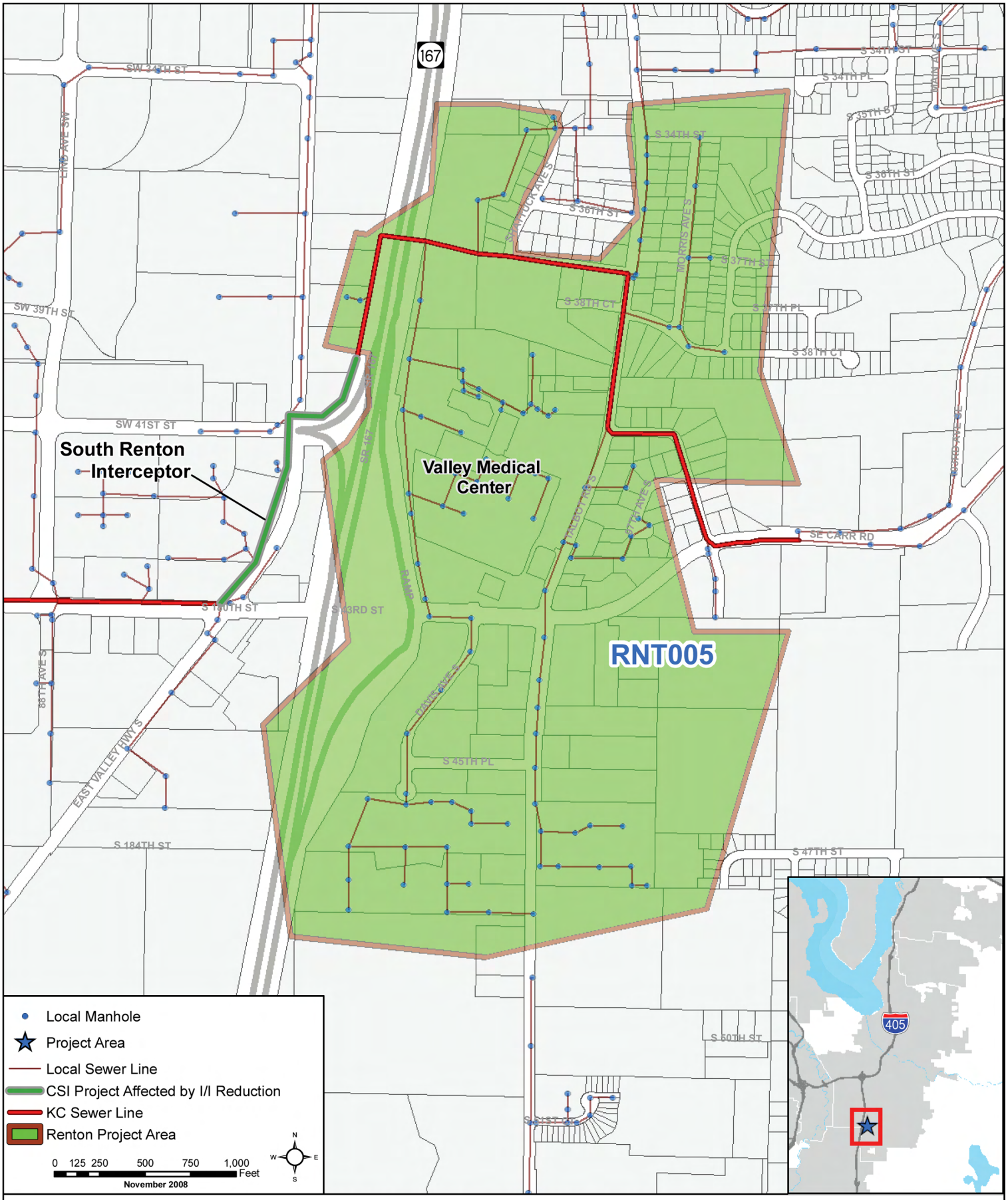
Affected CSI Projects

The CSI Program capital project downstream of this project area that is expected to be affected by I/I reduction in the project area is the Bryn Mawr Storage Facility, a 0.27-MG underground off-line storage facility to be located northwest of the Renton Airport. The project consists of a 12-foot diameter storage pipe with a small pump station to discharge stored flows after a peak flow event. Waterfront property acquisition costs have been included in the project cost estimate for siting the facility. The storage facility would limit downstream flow to the existing capacity of the Bryn Mawr Trunk. Flow reduction at the Bryn Mawr Storage Facility would also help to maintain available capacity in King County's Eastside Interceptor Section 1.

1.4 ALTERNATIVES ANALYSIS APPROACH

The analysis of alternatives for the initial I/I reduction project consisted of the following steps:

- The results of smoke testing and closed-circuit television (CCTV) inspection of sewer mains, laterals and side sewers were reviewed. Smoke testing and CCTV inspection help to identify specific locations where infiltration or inflow may be entering the sewer system.
- Flow monitors were installed in each project area during the 2007/2008 wet season. The data collected is to be used as follows:
  - The results were compared to previous flow monitoring data to identify where I/I conditions have changed since previous monitoring was performed, affecting the scope of potential I/I reduction measures.



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Renton_ProjectArea.mxd - peter keum
Data Source: King County

Figure 1 - 5

Renton Project Area

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Skyway_ProjectArea.mxd - peter keum
Data Source: King County

Figure 1 - 6

Skyway Project Area

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

  - The results allow assessment of whether I/I appears to be coming from shallow side sewers and laterals or from deeper sewer main lines, based on how quickly flows increase in response to rainfall.
  - The results provide "before-project" data that can be used to help assess the effectiveness of any implemented I/I reduction measures.
- Field visits and reviews of previous reports were performed for the following reasons:
  - Geotechnical, groundwater, environmental and storm drainage conditions were evaluated in the field and by review of existing documents to identify any locations where I/I reduction measures could have negative impacts on these conditions.
  - A field visit to a wetland in the Renton project area was conducted to identify manholes that may become submerged during heavy storm events, representing significant sources of inflow.
  - Limited field investigations were performed to assess conditions of individual parcels in the project areas that could affect constructability of I/I reduction measures.
- Rehabilitation unit costs were developed for each project area. The unit costs are for rehabilitation of sewer system components and are based on actual field conditions in each mini-basin. Each property in the project areas was assigned a rehabilitation difficulty rating (easy, medium or difficult) and associated unit cost for rehabilitation. The unit costs were used in developing overall project cost estimates for identified I/I reduction alternatives.
- I/I quantities were uniformly apportioned across each mini-basin and were equated to an average I/I per property in the mini-basin. The I/I allocation per property provided a benchmark for areas that would be most cost-effective to rehabilitate.
- Rehabilitation alternatives were developed that consisted of rehabilitation in single or multiple mini-basins, including alternatives that combine rehabilitation in the Issaquah and Eastgate project areas where there are mutual benefits in the reduction of regional downstream conveyance needs. The alternatives considered a range of I/I reduction effectiveness from 60 to 75 percent.

The alternatives analysis used criteria developed by the E&P Subcommittee. To be considered cost-effective under these criteria, an I/I reduction project must reduce, delay or eliminate a recommended downstream CSI project; and the associated cost savings must equal or exceed the cost of the I/I reduction project. A project was designated as "cost-effective" if its benefit/cost ratio, calculated as follows, is 1.0 or greater:

$$\text{Benefit/Cost Ratio} = \frac{\text{(CSI Project Cost Savings After I/I Reduction)}}{\text{(Cost of Proposed I/I Reduction Project)}}$$

In order to measure I/I reduction rates achieved and confirm the appropriateness of reducing or eliminating a downstream CSI project, the I/I Control Program will conduct flow monitoring within each project mini-basin after I/I reduction work has been completed. The results of the post-project evaluations will be presented to the E&P Subcommittee, and a recommendation regarding whether to proceed with additional I/I reduction projects will be presented to the King County Council.

CHAPTER 2.
SEWER SYSTEM EVALUATION SURVEY

The analysis of I/I reduction alternatives required a detailed assessment of the current physical condition of the sewer system in each project area as well as the best available estimates of current sewer flows and peak I/I levels. These characteristics were assessed through a sewer system evaluation survey (SSES) using updated flow monitoring, extensive CCTV inspection and smoke testing, and, in the Renton project area, limited dye testing. This chapter describes procedures and results for each element of the SSES.

2.1 ACCESS PROCEDURES

Prior to performing smoke testing and CCTV inspection, King County provided mailers to all residents in the project areas describing the methods of evaluation that would be performed and the general timing of the investigations. The mailers included a county contact person and phone number to address any questions or concerns that residents had about the investigations. All questions, concerns and requirements raised by the public were logged into a database for tracking the communications.

Smoke testing required physical access to each property to assess whether I/I sources were present. In the Eastgate, Issaquah and Renton project areas, city ordinances allowed access to properties for inspection purposes, and these rights were passed on to the county through interlocal agreements established with the agencies. Skyway Water and Sewer District does not have such ordinances, so a right-of-entry agreement from each property owner was required in order to perform the investigations. The county gathered all rights-of-entry required for the smoke testing in the Skyway project area.

2.2 FLOW MONITORING

2.2.1 Techniques and Requirements for Evaluation

New flow monitoring was performed to acquire current data on I/I flows in the project mini-basins, at selected downstream CSI project locations, and at selected control mini-basins where no I/I reduction is being considered. The flow monitoring results are to be used as follows:

- Current flow estimates for each mini-basin can be used to quantify and confirm the I/I reduction that could be achieved by projects in each mini-basin.
- Evaluation of how quickly flows increase after the start of rainfall events helps to identify whether I/I is entering the sewer system primarily through shallow side sewers and laterals or through deeper main sewers.
- Current flow estimates for each mini-basin serve as a “before-project” baseline value for comparison to “post-project” monitoring, in order to assess the effectiveness of implemented projects.
- Flow monitoring of the control mini-basins allows an assessment of the change in I/I over time for mini-basins where no I/I reduction project was implemented.

Monitoring was conducted from September 2007 through June 2008 using 23 flow meters throughout the four project areas. Meters were placed at the downstream outlet of mini-basins to measure mini-basin outflows, and, where necessary, at upstream locations to measure flows into the mini-basin. Proposed monitoring locations were physically inspected prior to the installation of the flow meters to assess ease of access, safety, availability of a telemetry connection, and physical and hydraulic suitability. Accessible

sites with suitable flow characteristics that would produce high-quality flow data were selected. County field crews installed and field-verified each flow monitor.

The monitors measured sewer flow depth and velocity and calculated flow rate from the measured parameters. Details on the monitor installation and data collection and analysis methods are provided in *Initial I/I Projects Flow Monitoring Report* (King County, August 2008). Results of the monitoring were used by King County's modeling group to produce the estimates of I/I for each mini-basin used in this project.

2.2.2 Eastgate Flow Monitoring Results

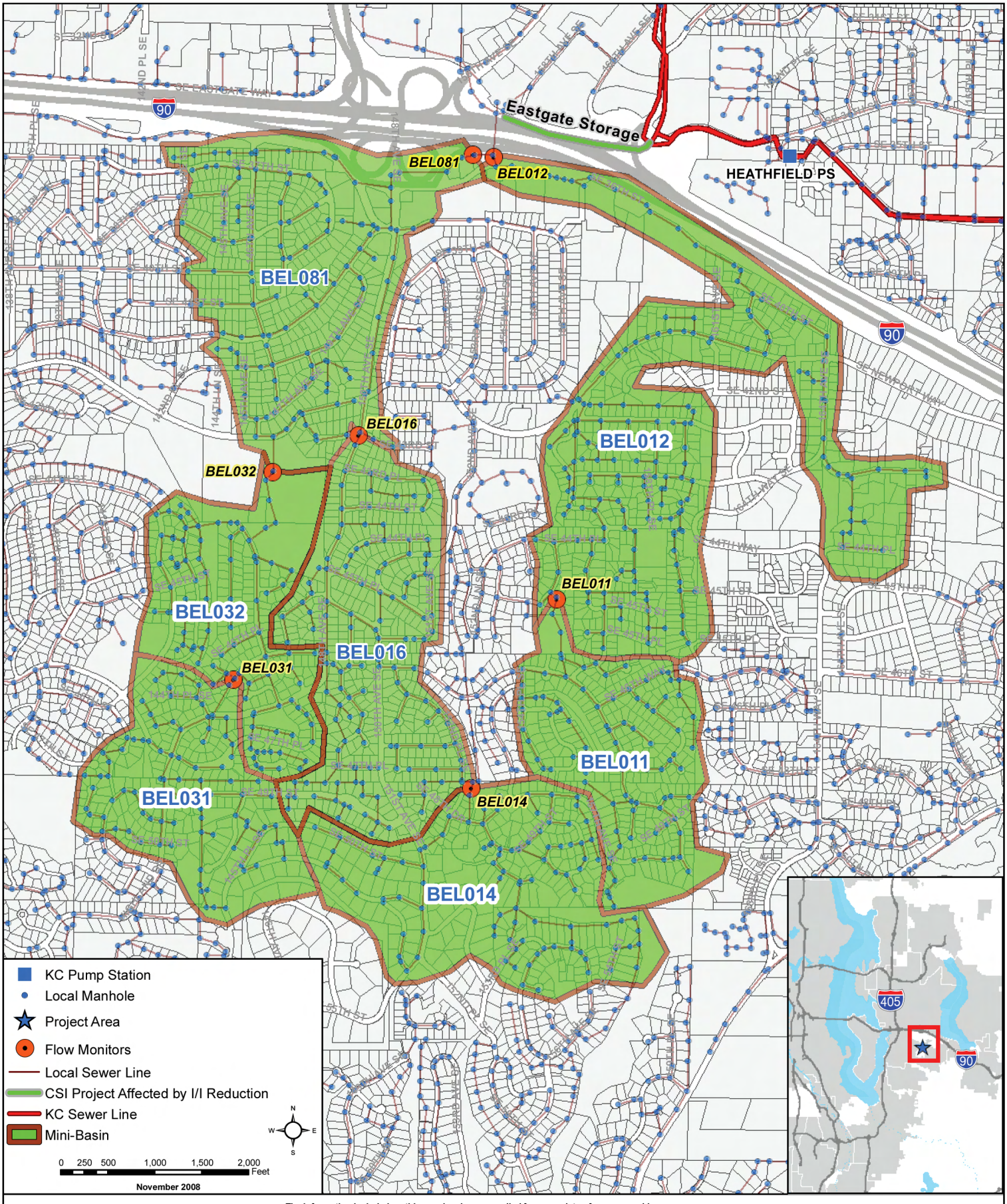
Seven monitoring locations were established to evaluate flows for the five Eastgate mini-basins, one control mini-basin, and the location of the downstream Eastgate Storage CSI project. The Eastgate flow monitoring locations are shown in Figure 2-1 and described in Table 2-1.

TABLE 2-1.
EASTGATE PROJECT AREA FLOW MONITORING LOCATIONS

Monitor ID	Monitoring Location	Flows Monitored	Reporting Period
BEL011	Middle of SE 44th Court	Mini-Basin BEL011 outflows; Mini-Basin BEL012 inflows	9/1/2007 – 6/13/2008
BEL012	North side of 37th Road, along chain link fence facing I-90 in field	Mini-Basin BEL012 outflows	9/1/2007 – 6/13/2008
BEL014	4800 SE 152nd Place	Mini-Basin BEL014 outflows	9/1/2007 – 6/10/2008
BEL016	In the middle of intersection of 150th Avenue SE and SE 43rd Street	Control Mini-Basin BEL016 outflows	9/1/2007 – 6/13/2008
BEL031	In street SE 46th, opposite 14503	Mini-Basin BEL031 outflows; Mini-Basin BEL032 inflows	9/1/2007 – 6/13/2008
BEL032	In entrance driveway of East Gate Park	Mini-Basin BEL032 outflows	9/1/2007 – 6/13/2008
BEL081	In parking lot behind 15220 37th SE (76 gas station) by fence closest to I-90	Eastgate Storage CSI project inflows	9/1/2007 – 6/13/2008

The monitoring results were integrated into the existing county hydraulic models to provide a comparison between the latest monitoring results and previous model predictions. The results compared favorably in all five Eastgate mini-basins. An example of this, for Mini-Basin BEL011, is shown in Figure 2-2, which compares the measured flow in the mini-basin to the flow rate predicted by the model for the same measured rainfall event. The two lines track very close to one another, indicating that previous assumptions for I/I levels in the mini-basin are valid.

The flow monitoring results for all five mini-basins continue to exhibit a rapid response to rainfall, indicating that side sewers, sewer laterals and inflow sources are the most likely contributors to I/I.



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project\TechReport\Eastgate_ProjectArea.mxd - peter keum
Data Source: King County

Figure 2 - 1
Eastgate Project Area
Flow Monitor Locations
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

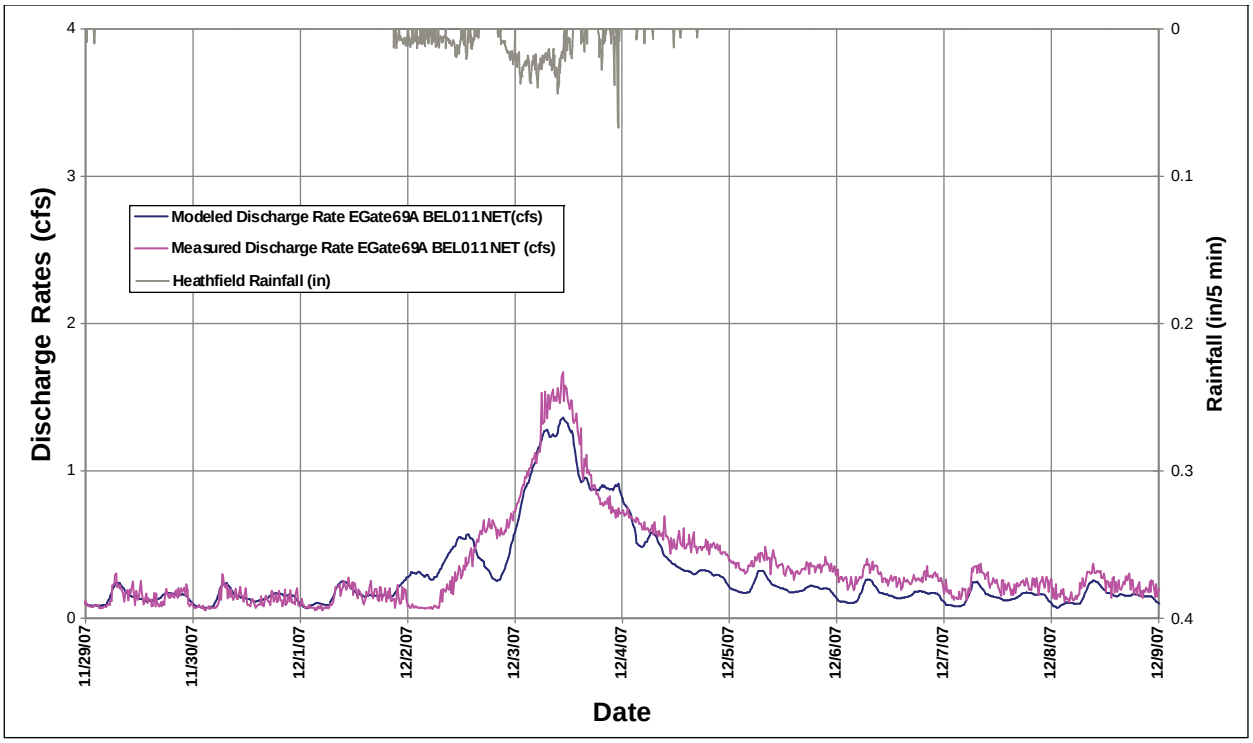


Figure 2-2. Modeled and Measured Flow Comparison for Mini-Basin BEL011

2.2.3 Issaquah Flow Monitoring Results

Six monitoring locations were established to evaluate flows for the two Issaquah mini-basins, one control mini-basin, and the location of the downstream Issaquah Storage CSI project. The Issaquah flow monitoring locations are shown in Figure 2-3 and described in Table 2-2.

TABLE 2-2.
ISSAQUAH PROJECT AREA FLOW MONITORING LOCATIONS

Monitor ID	Monitoring Location	Flows Monitored	Reporting Period
ISS002	Intersection of Sunrise Place SW and Wildwood Blvd	Mini-Basin ISS003 inflows	9/1/2007 – 6/13/2008
ISS003	Across from 40 Newport Way close to Newport Way and Sunset Way intersection	Mini-Basin ISS003 outflows; Mini-Basin ISS004 inflows	9/1/2007 – 6/13/2008
ISS004	595 Newport Way NW (Morgan Manor)	Mini-Basin ISS004 outflows	9/1/2007 – 6/13/2008
ISS014	Intersection of Mountain Park and Mt Everest Lane SW	Mini-Basin ISS004 inflows	9/1/2007 – 6/13/2008
ISSAQ038	1500 19th Avenue NW in front of Bldg #10	Control Mini-Basin ISSAQ038 outflows	9/1/2007 – 6/13/2008
ISSCK39A	1875 NW Poplar Way	Issaquah Storage CSI Project inflows	9/1/2007 – 6/13/2008

The flow monitoring results compared favorably with previous model data for Mini-Basin ISS003, as shown in Figure 2-4. The results for Mini-Basin ISS004 are less conclusive because the flow monitor was not functioning properly during the peak of the storm event. Figure 2-5 compares the flow monitoring results and predicted model flows for Mini-Basin ISS004. The flow monitoring results for Mini-Basin ISS003 continue to exhibit a rapid response to rainfall, indicating potential defects in side sewers, sewer laterals and inflow sources.

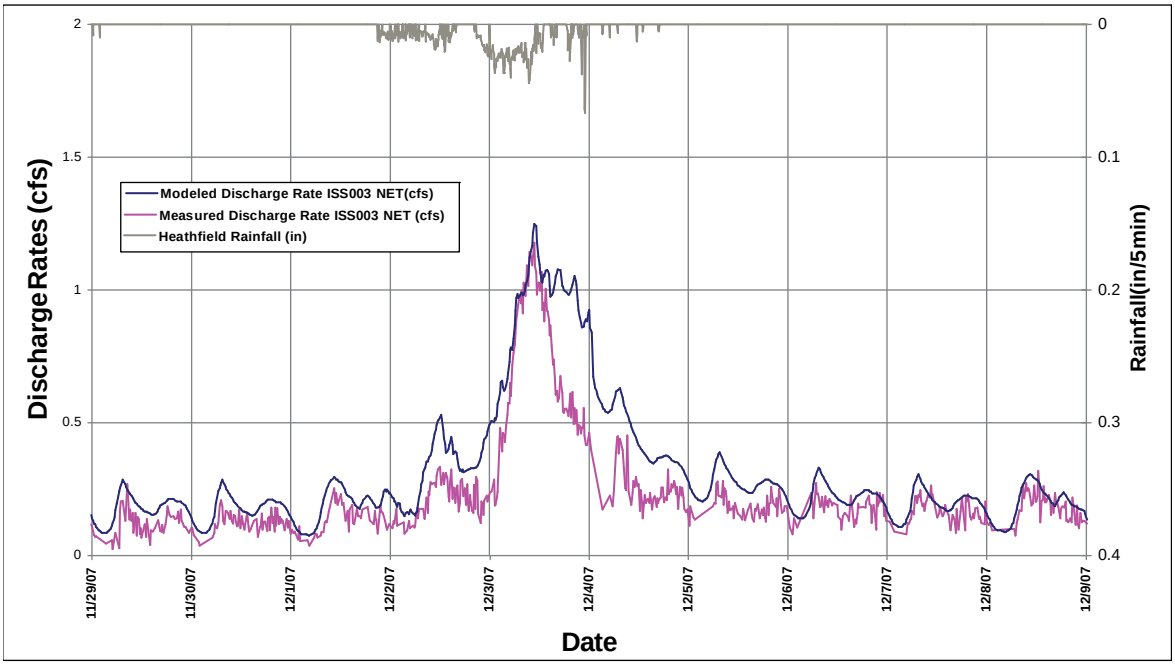


Figure 2-4. Modeled and Measured Flow Comparison for Mini-Basin ISS003

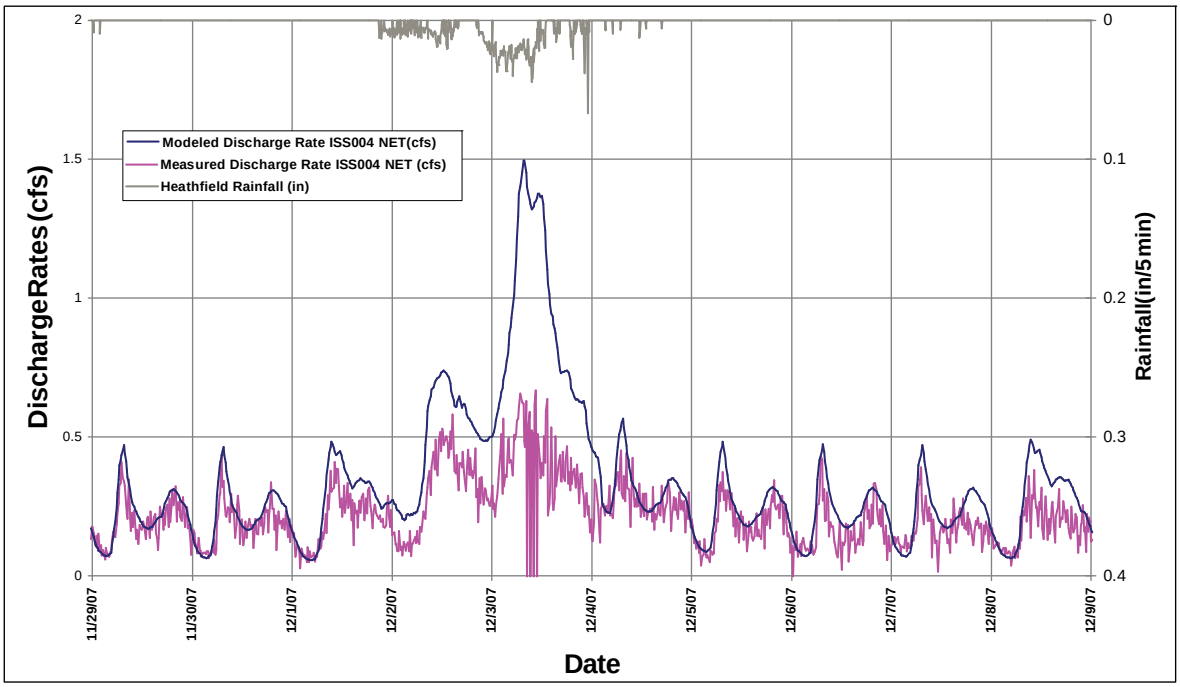
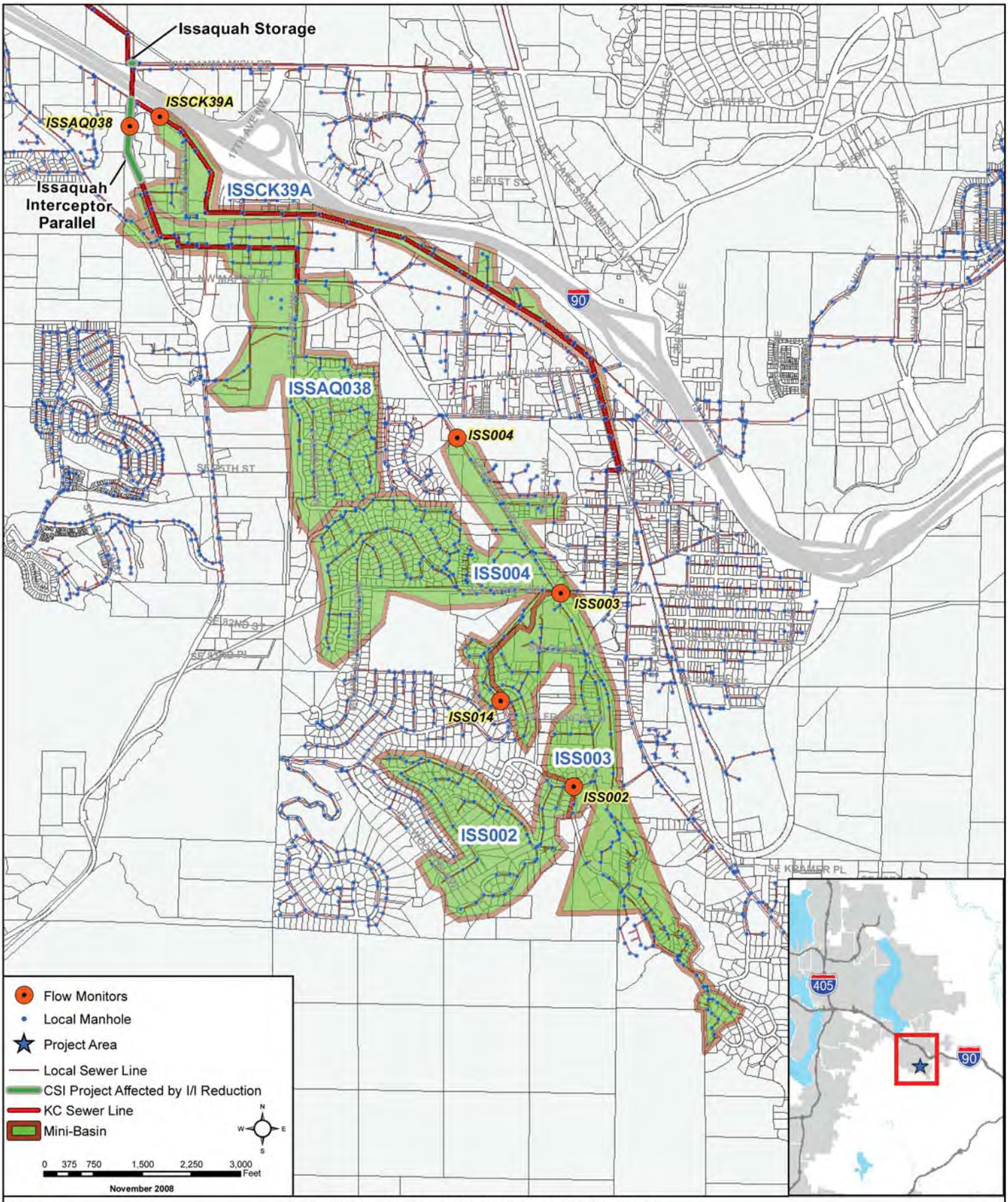


Figure 2-5. Modeled and Measured Flow Comparison for Mini-Basin ISS004



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Issaquah_ProjectArea_Flowmonitors.mxd - peter keum
Data Source: King County

Figure 2 - 3
Issaquah Project Area
Flow Monitor Locations
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

2.2.4 Renton Flow Monitoring Results

Four monitoring locations were established to evaluate flows for the one Renton mini-basin and the location of the downstream South Renton Interceptor CSI project. The Renton flow monitoring locations are shown in Figure 2-6 and described in Table 2-3.

The results of the flow monitoring do not show the same levels of peak flow and I/I predicted by previous modeling. Figure 2-7 shows a relatively modest peak flow during the peak of the December 3, 2007 storm event. The model predicted much higher peak flows for the event. One possible explanation for the discrepancy is that a previous inflow source in the mini-basin is no longer present. This possibility is discussed in Section 2.6.6.

TABLE 2-3.
RENTON PROJECT AREA FLOW MONITORING LOCATIONS

Monitor ID	Monitoring Location	Flows Monitored	Reporting Period
RNT005	In the back of car lot of Yonker Nissan 5 feet from fence next to light post	Mini-Basin RNT005 outflows; South Renton Interceptor CSI Project inflows	9/1/2007 – 6/13/2008
RNT006	3431 Shattuck Avenue South	Mini-Basin RNT005 inflows	9/1/2007 – 6/13/2008
SOO021	Intersection of 98 Ave S and S 178th Street	Mini-Basin RNT005 inflows	9/1/2007 – 6/13/2008
SRENT21	404 South 37th Street across street on edge of field	Mini-Basin RNT005 inflows (installed to verify SOO021)	1/10/2008 – 6/13/2008

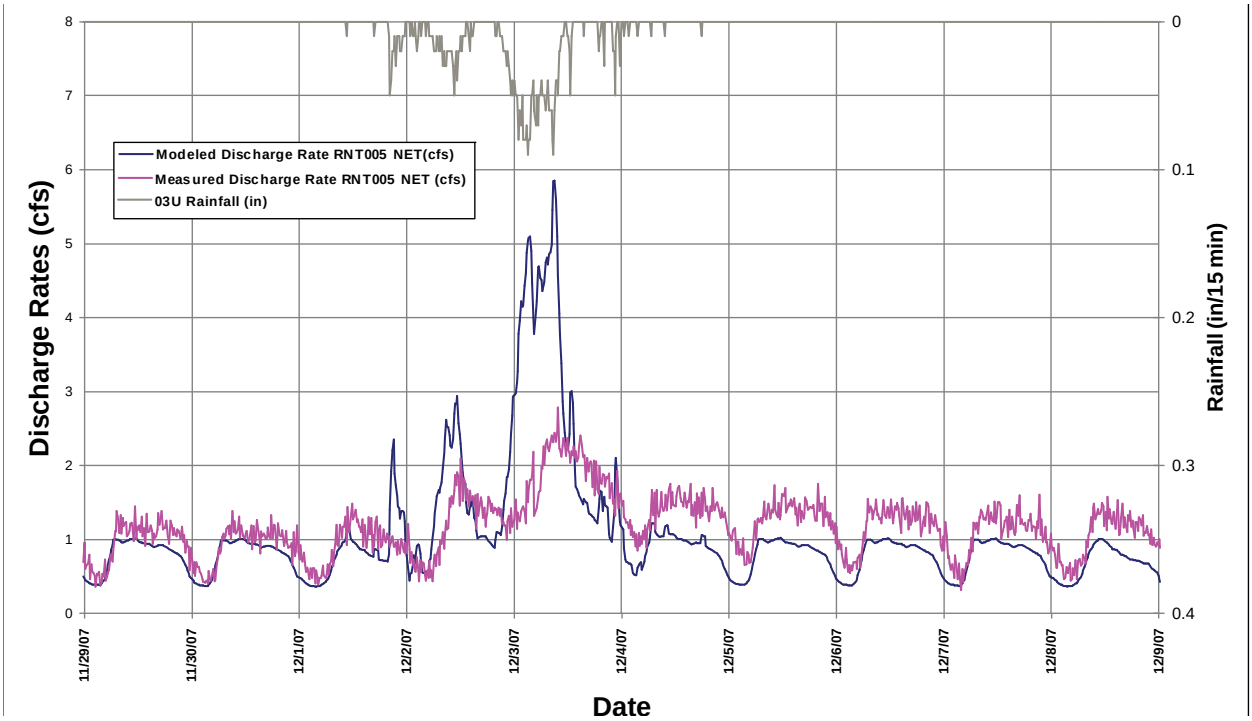


Figure 2-7. Modeled and Measured Flow Comparison for Mini-Basin RNT005

2.2.5 Skyway Flow Monitoring Results

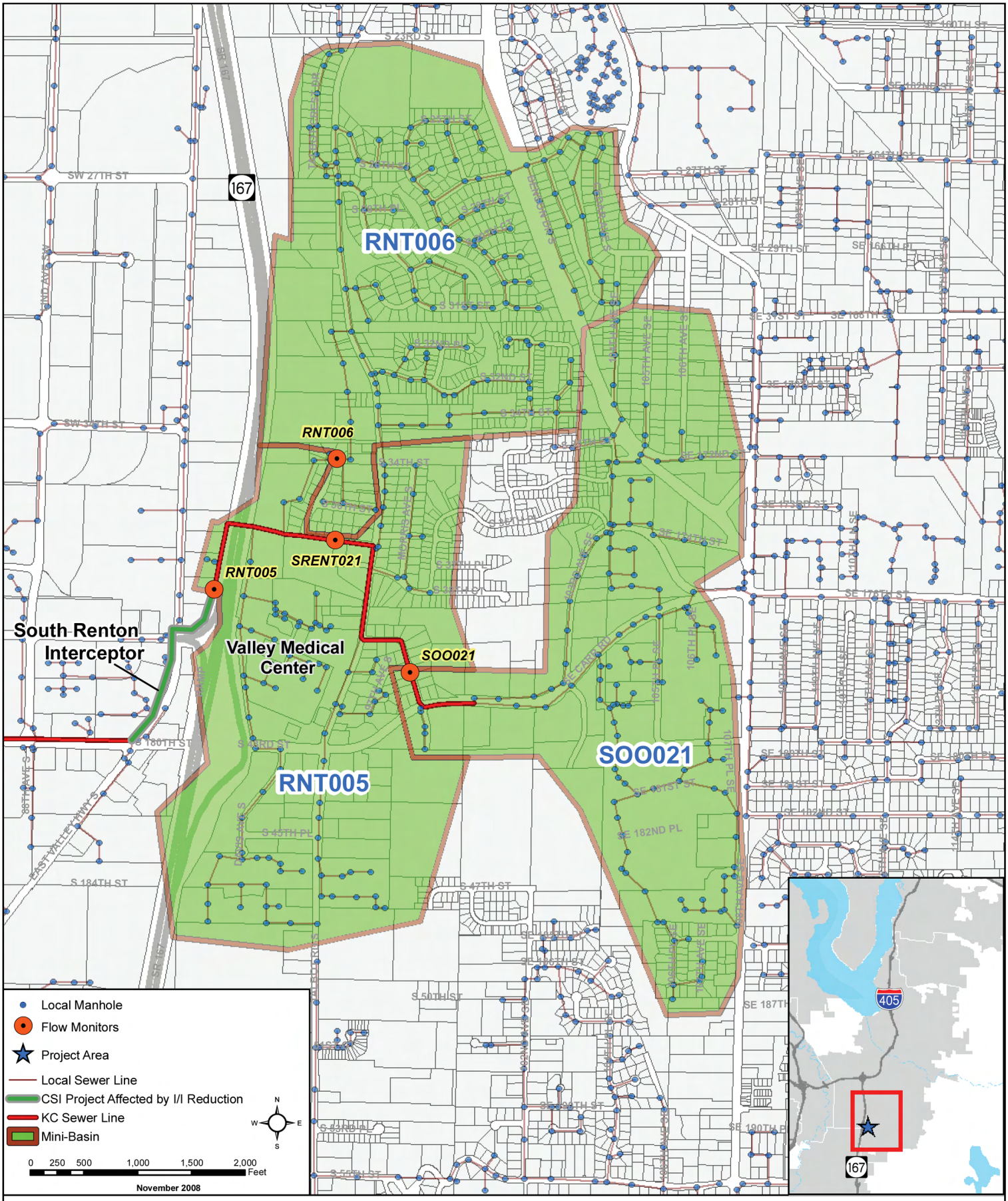
Six monitoring locations were established to evaluate flows for the three Skyway mini-basins, one control mini-basin, and the location of the downstream Bryn Mawr Storage CSI project. The Skyway flow monitoring locations are shown in Figure 2-8 and described in Table 2-4.

Flow monitoring results compared favorably with predicted model results for Mini-Basins BLS001 and BLS003, as shown in Figures 2-9 and 2-10. Monitoring in Mini-Basin BLS002 shows high levels of I/I remain in the mini-basin. The monitoring results do not appear to compare favorably with the predicted model results in this mini-basin; this is because the model did not include the I/I reductions that were achieved following the pilot project construction. When the approximately 3.9 cubic feet per second (cfs) peak I/I reduction attained in the mini-basin is factored into the predicted model results, the comparative results are more favorable. Figure 2-11 compares flow monitoring results and predicted model flows for Mini-Basin BLS002.

The flow monitoring results for all three mini-basins exhibit a rapid response to rainfall, indicating potential defects in side sewers, sewer laterals and inflow sources.

TABLE 2-4.
SKYWAY PROJECT AREA FLOW MONITORING LOCATIONS

Monitor ID	Monitoring Location	Flows Monitored	Reporting Period
BLS001	11900 87th Ave. South	Mini-Basin BLS001 outflows	9/1/2007 – 6/13/2008
BLS002	11015 Rainer Ave. S. In side walk in front of house	Mini-Basin BLS002 outflows	11/10/2007 – 6/5/2008
BLS003	8421 S. 114th St.	Mini-Basin BLS003 outflows	9/1/2007 – 6/13/2008
BLS003A	8225 S. 116th St. in East bound lane	Mini-Basin BLS003 inflows (installed to avoid adding an upstream subtraction meter)	9/6/2007 – 6/13/2008
BLS006	8050 S. 114th St.	Control Mini-Basin BLS006 outflows; Mini-Basin BLS003 inflows	9/17/2007 – 6/13/2008
BLS43B	11416 Rainer Ave. S., upstream of flow meter vault (west of siphon inlet structure)	Bryn Mawr Storage CSI Project inflows	9/1/2007 – 6/13/2008



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Renton_ProjectArea_Flowmonitors.mxd - peter keum
Data Source: King County

Figure 2 - 6
Renton Project Area
Flow Monitor Locations
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Skyway_ProjectArea_Flowmonitors.mxd - peter keum
Data Source: King County

Figure 2 - 8
Skyway Project Area
Flow Monitor Locations
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

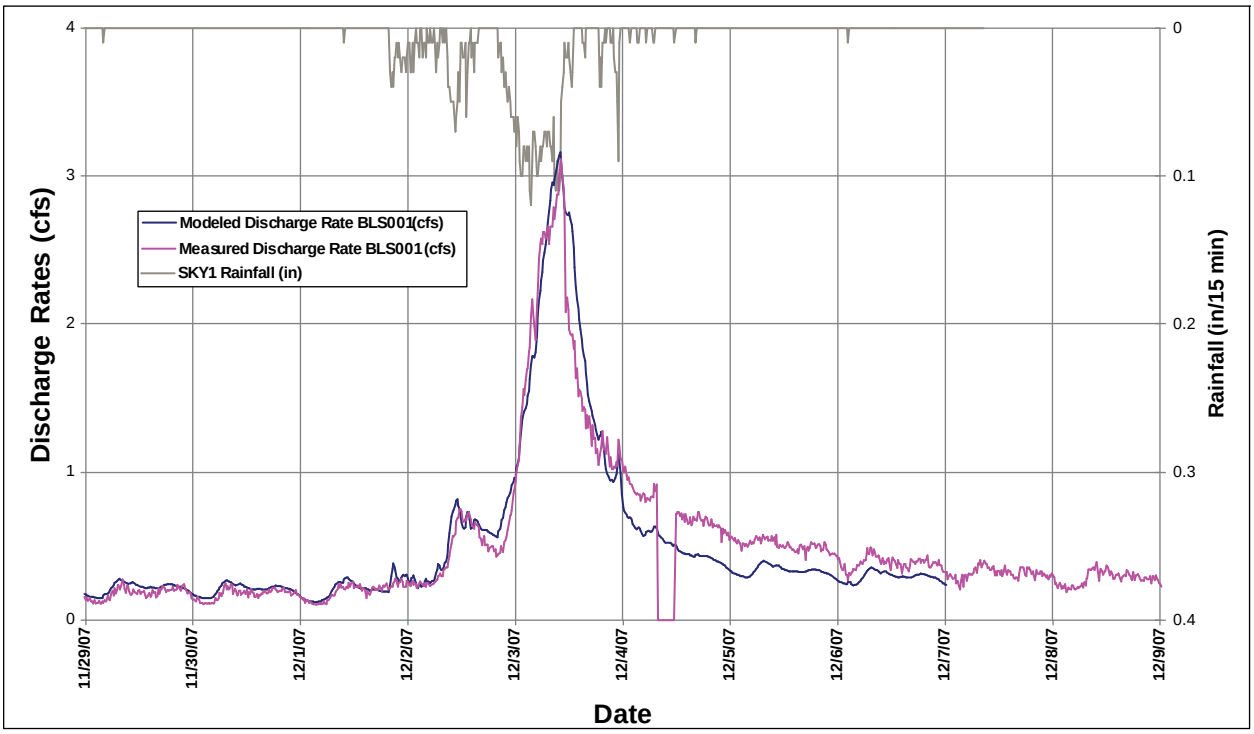


Figure 2-9. Modeled and Measured Flow Comparison for Mini-Basin BLS001

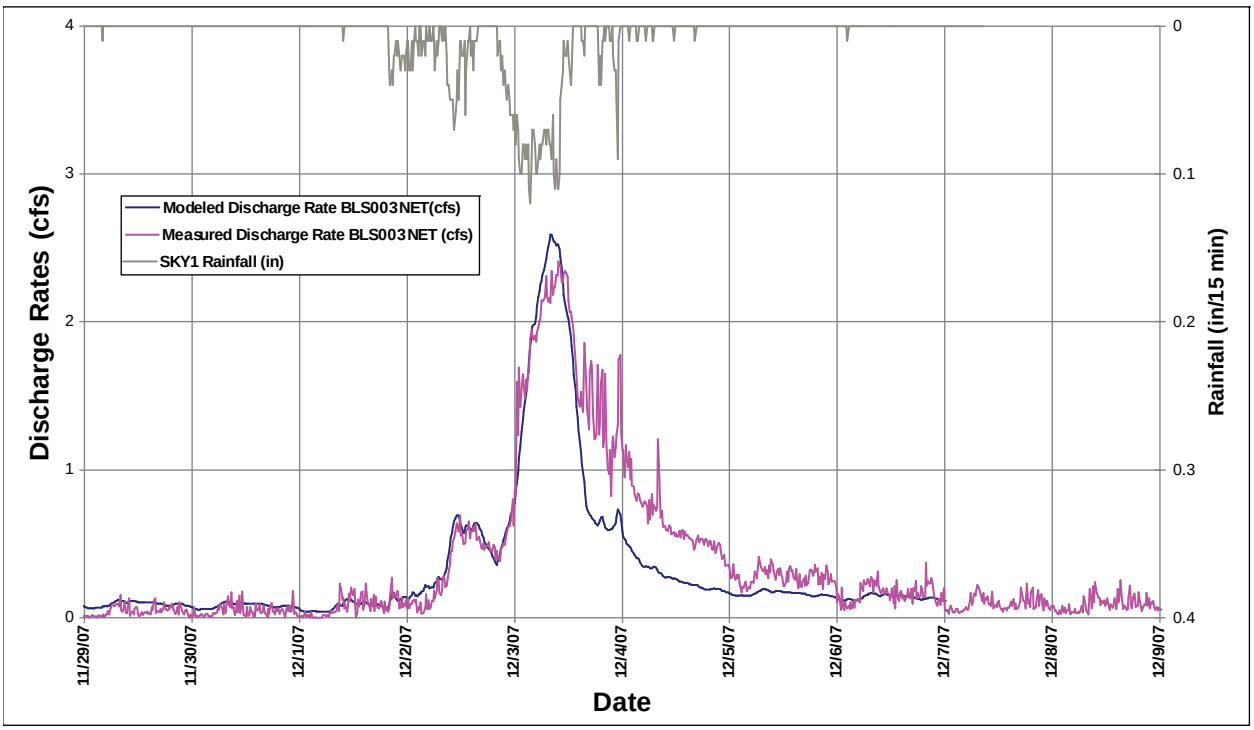


Figure 2-10. Modeled and Measured Flow Comparison for Mini-Basin BLS003

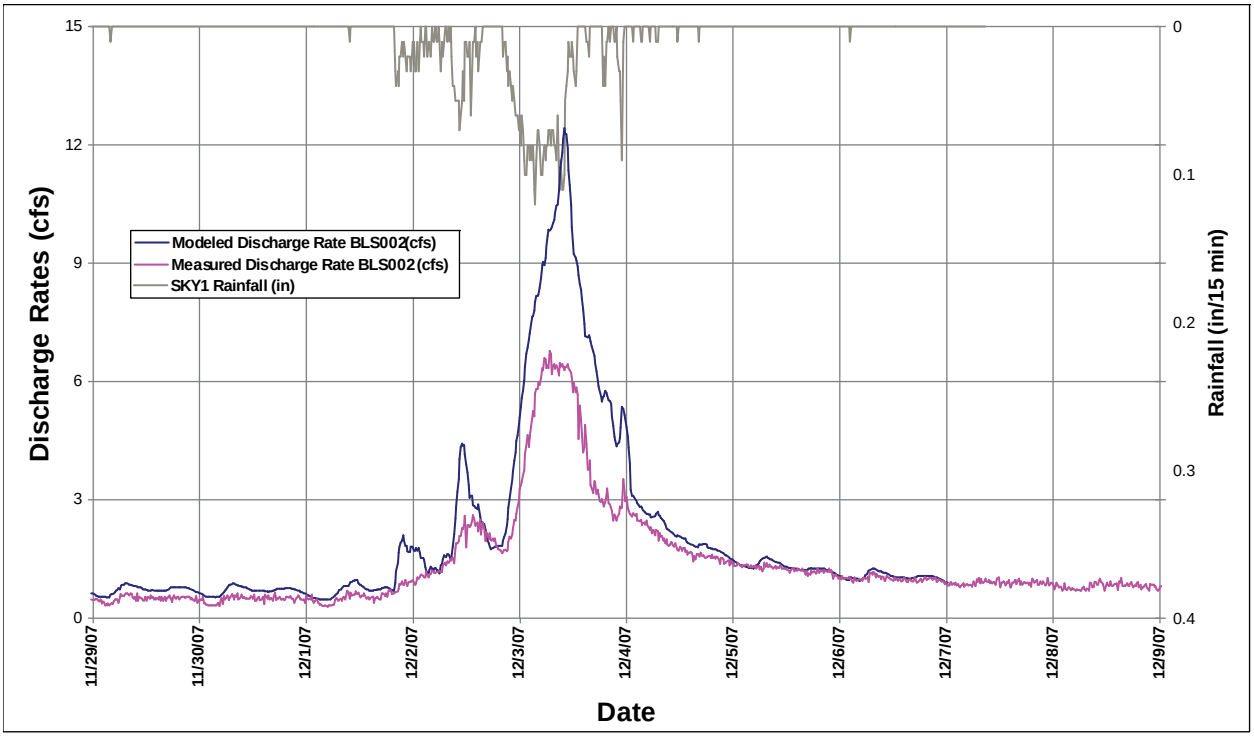


Figure 2-11. Modeled and Measured Flow Comparison for Mini-Basin BLS002

2.3 CCTV INSPECTION

2.3.1 Techniques and Requirements for Evaluation

Closed circuit television (CCTV) inspections use remotely operated video cameras to assess the condition of an existing main sewer, side sewer or lateral, and to identify potential sources of I/I. CCTV inspection provides a means to identify illegal connections, bad connections and joints, and structural and operational defects in the sewer.

CCTV inspection for this project consisted of running a remotely operated camera through sewer mains and recording the results on DVDs for review by design engineers. The cameras also had the ability to launch a second cable mounted camera out of the sewer main and into a sewer lateral and side sewer. Field work required to facilitate the inspection, such as hydraulic cleaning, root removal and debris removal, was performed before the inspection began.

CCTV work is best performed during a rainfall event after groundwater levels have begun to rise, allowing visual confirmation of specific I/I entry points. A small amount of the CCTV work for this project was completed during periods of high precipitation, but much of it took place during dry weather, so it was difficult to pinpoint specific locations where I/I is entering the system.

2.3.2 Eastgate CCTV Analysis

Scope of Investigation

The extent of the CCTV analysis in the Eastgate project area was as follows:

- Mini-Basin BEL011—Approximately 12,000 feet of 8-inch-diameter sewer mains and 4,500 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 119 individual laterals and side sewers were inspected in the mini-basin.
- Mini-Basin BEL012—Approximately 26,000 feet of 8-, 12- and 15-inch-diameter sewer mains and 8,500 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 223 individual laterals and side sewers were inspected in the mini-basin.
- Mini-Basin BEL014—Approximately 27,500 feet of 8-inch-diameter sewer mains and 7,200 feet 6-inch-diameter laterals and side sewers were inspected. A total of 192 individual laterals and side sewers were inspected in the mini-basin.
- Mini-Basin BEL031—Approximately 14,500 feet of 8-inch-diameter sewer mains and 6,000 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 154 individual laterals and side sewers were inspected in the mini-basin.
- Mini-Basin BEL032—Approximately 16,000 feet of 8-inch-diameter sewer mains and 5,500 feet of 4-, 6-inch-diameter laterals and side sewers were inspected. A total of 181 individual laterals and side sewers were inspected in the mini-basin.

General System Age and Materials

Most of the sewer system serving the Eastgate project area was constructed in the 1970s; the system was built in 1970 in Mini-Basin BEL031, in 1976 in Mini-Basins BEL031 and BEL011, and in 1979 in Mini-Basin BEL012. The only exception is Mini-Basin BEL014, where the system was built in 1980.

Sewer mains in the Eastgate project area consist primarily of cement concrete pipe. The vast majority of side sewer and lateral pipe materials also are of cement concrete pipe, although PVC side sewers are used in isolated pockets. PVC laterals and side sewers are installed on less than 10 percent of the total number of properties in most of the project area. The exception is Mini-Basin BEL014, which has more extensive areas of both PVC mains and PVC side sewers and laterals.

Deficiencies and Observed I/I Sources

Deficiencies identified through CCTV inspection did not include many structural problems. A few offset or separated joints in the mains were observed, but these were infrequent and indicated no larger patterns for the overall system.

A generally consistent deficiency was observed with regards to the joint conditions in the laterals and side sewers. These sewers were largely constructed of cement concrete pipe with ungasketed joints, which was typical for the era of construction and the size of these lines. This type of joint construction is extremely susceptible to infiltration as well as root intrusion and loss of bedding and support material at the joint. Few structural defects were noted, but there were many instances of root intrusion and separated joints.

2.3.3 Issaquah CCTV Analysis

Scope of Investigation

The extent of the CCTV analysis in the Issaquah project area was as follows:

- Mini-Basin ISS003— Approximately 16,000 feet of 8-inch-diameter sewer mains and 1,200 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 51 individual laterals and side sewers were inspected in the mini-basin.

- Mini-Basin ISS004— Approximately 27,000 feet of 8-, 12- and 15-inch-diameter sewer mains and 2,000 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 177 individual laterals and side sewers were inspected in the mini-basin.

General System Age and Materials

The sewer system in the Issaquah project area consists of a wide variety of pipe material, such as concrete segments unbolted (CSU), PVC, ductile iron (DI), asbestos cement (AC), polyethylene (PE) and some other unidentified pipe materials. Most of the single-family neighborhoods in the project area were built in early 1960s and 1970s with concrete pipe mains, laterals and side sewers. Newer construction of both single-family and multi-family areas generally used PVC pipe for mains, laterals and side sewers.

Of the inspected sewer mains in Mini-Basin ISS003, 52 percent of pipes were CSU pipes, 41 percent were PVC pipes, 4 percent were DI pipe, and the remainder were unidentified materials. Of the lateral sewers inspected, 20 percent were PVC and 80 percent were concrete.

Of the inspected sewer mains in Mini-Basin ISS004, 43 percent of pipes were CSU pipes, 50 percent were PVC pipes, and the remainder were varying materials. Of the lateral sewers inspected, 70 percent were PVC and the rest were concrete or AC pipe.

Deficiencies and Observed I/I sources

Most of the main lines in Mini-Basin ISS003 have moderate to few defects, with the CSU pipes having the majority of the defects. For most of the laterals, the inspection was not completed due to frequent changes in pipe size and/or orientation. Still, about 50 percent of the concrete laterals and 50 percent of the PVC laterals were found to have structural defects in this mini-basin.

The CSU pipes in Mini-Basin ISS004 have more defects than the pipes made of PVC and other materials. About 60 percent of the concrete laterals and 45 percent of the PVC laterals were found to have structural defects in this mini-basin.

CCTV videos indicated that few of the main lines and laterals in the Issaquah project area had evidence of infiltration (deposits and encrustation on the walls of the pipe, and fine to medium root intrusions in the pipe). This indicates that this project area is a low to medium source of slow-response infiltration.

2.3.4 Renton CCTV Analysis

Scope of Investigation

CCTV inspection of the Renton project area included mains on the west side of SR-167, a sewer main under SR-167, mains west of the Valley Medical Center and north of South 43rd Street, the three mains serving the hospital, and one main in the South 37th Street alignment. The focus of the inspection was to identify pipe defects and I/I in the wetland area northwest of the hospital. Roughly 5,000 feet of 8-through, 24-inch-diameter sewer mains were inspected in Mini-Basin RNT005. No laterals or side sewers were inspected in this basin.

General System Age and Materials

Most of the single-family development in the Renton project area is served by concrete pipe installed in the 1960s and 1970s. Most of the commercial and multi-family development is served by concrete pipe installed in the 1980s and 1990s, with some PVC pipe in areas of newer construction.

Deficiencies and Observed I/I sources

Overall, the inspected pipes are in generally good condition. There were some signs of infiltration at pipe joints, indicated by light root intrusion and encrustation. Small amounts of infiltration were observed in a few locations. Some minor corrosion problems were noted, but none that indicated structural problems. Indicators of potential future problems were the large number of sags in the mains and a few misaligned joints. One pipe has already been repaired.

The pipeline in the wetland was in the worst condition of those inspected. These pipes are shallow (5 to 6 feet deep) and have large cottonwood trees growing near and on top of them; a few of the trees have fallen over. Several of the manholes in this area are buried, likely because of the heavy growth of grass and shrubs, which trap soils being transported by moving water and contribute material through their own death and decay that can help bury the manholes.

2.3.5 Skyway CCTV Analysis

Scope of Investigation

The extent of the CCTV analysis in the Skyway project area was as follows:

- Mini-Basin BLS001—Approximately 12,000 feet of 6-, 8- and 12-inch-diameter sewer mains and 3,100 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 88 individual laterals and side sewers were inspected in the mini-basin.
- Mini-Basin BLS002—This mini-basin was added to the project area after the study had begun, so CCTV inspection was conducted on a limited portion of the basin. Approximately 2,200 feet of 8-inch-diameter sewer mains and 400 feet of 6-inch-diameter laterals and side sewers were inspected. A total of 12 individual laterals and side sewers were inspected in this mini-basin.
- Mini-Basin BLS003— Approximately 8,500 feet of 8-inch-diameter sewer mains and 1,800 feet of 4-, and 6-,inch-diameter laterals and side sewers were inspected. A total of 41 individual laterals and side sewers were inspected in the mini-basin..

General System Age and Materials

Most of the sewer system in the Skyway project area was built during the late 1950s and early 1960s. The sewer system consists of a wide variety of pipe material, such as CSU, PVC, clay tile (CT) pipe and some other unidentified pipe materials. The materials observed in the CCTV analysis were as follows:

- Mini-Basin BLS001—Of the inspected sewer mains, 79 percent were CSU pipe, 19 percent were PVC (both 8-inch and 12-inch), and 2 percent were CT pipe. Of the lateral sewers inspected, 67 percent were concrete pipe and the remainder were PVC.
- Mini-Basin BLS002—All the main lines and laterals inspected were CSU pipe.
- Mini-Basin BLS003—Of the inspected sewer mains, 94 percent were CSU pipe and the remainder were PVC. Of the lateral sewers inspected, 88 percent were CSU pipe and the remainder were PVC.

Deficiencies and Observed I/I sources

A major portion of the CSU mains and CT mains in Mini-Basin BLS001 have substantial defects. The inspection videos showed structural defects to the main lines such as exposed aggregate and encrustation. The PVC mains inspected showed no visible infiltration. Approximately 61 percent of the CSU laterals

and 22 percent of the PVC laterals inspected had defects. Based on the CCTV inspection results, the main lines and laterals in this mini-basin are moderately to severely defective.

CCTV inspection videos in Mini-Basin BLS002 indicated defects including broken pipes, cracks, exposed aggregates, sags in the pipe and encrustation around the joints of the pipe. Based on the number of general visual observations, pipe defect observations and infiltration observations, the main lines in this mini-basin are moderately to severely defective and require rehabilitation. About 75 percent of laterals inspected were found defective in this mini-basin. Most of the main lines and laterals in this mini-basin have a high number of defects and require rehabilitation.

The CSU mains in Mini-Basin BLS003 have more defects than the PVC main lines. CCTV videos indicated that the defects include rough pipe surface, stains on the pipe wall, exposed aggregates and encrustation around the pipe joints. The PVC mains inspected showed no visible infiltration. Approximately 40 percent of the CSU laterals and 25 percent of the PVC laterals inspected were found defective in this mini-basin.

2.4 SMOKE TESTING

2.4.1 Techniques and Requirements for Evaluation

Smoke testing is done by blowing low-pressure, non-toxic, non-staining vapor or smoke into a section of sewer line through manholes, allowing the smoke to flow through the system and escape at any exposed surface connection to the system. Smoke testing is used to identify two types of I/I:

- Direct inflow connections—Direct connections for surface water to enter the sanitary sewer system typically include pipes from roof drains, cross connections from storm sewer systems, open cleanouts, and holes in a sewer pipe that are exposed to the ground surface. These are identified by smoke rising from an identifiable source during the test, such as a roof downspout or a cleanout.
- Sewer system defects (infiltration)—Smoke leaks rising from the ground rather than from an observable structure generally indicate defects in sewer mains, laterals, side sewers and manholes. These smoke sources may indicate the need for rehabilitation if the observed leaks are in locations where surface water runoff flows over or near the manholes. Smoke testing only indicates these types of problems above the flow line in the pipe; the smoke does not indicate holes and cracks below the flow line and it cannot indicate problems for broken pipes that are buried too deep in the ground.

In the evaluation of I/I reduction measures, it is assumed that direct inflow connections can be disconnected relatively easily and inexpensively to reduce I/I. In order to estimate the reduction benefit of these direct disconnects, the quantity of flow entering the sewer system at sources where smoke tests indicated direct inflow connections was estimated based on the following equation:

$$Q = C * i * A * (448.83/43{,}560)$$

Where

Q = Peak flow in gallons per minute (gpm).

C = Runoff coefficient; a runoff coefficient of 0.9 was used for runoff from highly impervious areas such as roofs and pavement, and a runoff coefficient of 0.35 was used for less impervious areas such as lawns.

i = Peak-hour rainfall intensity in inches per hour; a peak-hour rainfall intensity of 0.7 inches per hour was assumed.

A = Tributary area in square feet; tributary areas were approximated from the smoke testing videos.

(448.83/43,560) = Is a factor to convert area from acres to square feet and flow from cubic feet per second to gallons per minute.

2.4.2 Smoke Test Results

Smoke testing showed a significant number of I/I sources in the Eastgate and Skyway project areas, but few in the Issaquah and Renton project areas:

- In the Eastgate mini-basins, 33 instances of smoke leakage were observed, of which 15 indicated direct inflow connections.
- In the Skyway mini-basins, 127 instances of smoke leakage were observed, of which 53 indicated direct inflow connections. A comparison between the CCTV inspection videos and the smoke testing videos for Mini-Basins BLS001 and BLS003 indicated broken laterals at the point where smoke was generated on the ground, suggesting that these mini-basins have sources of infiltration. No correlation was obtained between the smoke testing data and the CCTV inspections for Mini-Basin BLS002 as CCTV was performed on few laterals in this mini-basin.
- Only three leaks were observed in Issaquah, all of which indicated direct inflow.
- Smoke testing was not performed in the Renton project area near Valley Medical Center due to concerns of smoke getting into the hospital buildings. Smoke testing in other portions of the Renton project area yielded seven hits—four at sewer line cleanouts, two around the lids of manholes, and one in a side sewer that was temporarily cut during construction at the hospital. None were in areas where inflow would be considered a problem, and no inflow quantity estimates were made.

Figures 2-12 and 2-13 show the distribution of observed smoke leaks in the Eastgate and Skyway project areas, respectively. Table 2-5 summarizes the smoke test results for all four project areas.

2.5 ADDITIONAL RENTON PROJECT AREA INVESTIGATIONS

2.5.1 Dye Testing

Dye testing was performed in lieu of smoke testing to evaluate the system around Valley Medical Center in the Renton project area. The dye test consisted of placing a fluorescent dye into the storm drainage system around the hospital. The dye was flushed down catch basins, drains and downspouts around the building and parking garages. If the dye showed up in the sanitary sewer, this would indicate a connection between the storm drainage system and the sanitary sewer. The dye testing did not indicate any such connections.

2.5.2 Field Visit

A field visit to the Renton project area the day after the heavy December 3, 2007 storm investigated inflow problems in the wetland west of Valley Medical Center (see Figure 2-14). Ten manholes were investigated. Several had lids at ground level, and some were underwater the day of the field visit or showed evidence of having been underwater within the previous day. It was assumed that large amounts of inflow had entered the sewer system through the pick-holes on submerged manhole lids. One manhole was buried about 18 inches below the ground surface; another is almost within the channel of a drainage ditch.

TABLE 2-5.
SMOKE TEST RESULTS

Mini-Basin	Total Observed Smoke Leaks[a]	Leaks Indicating Direct Inflow Connection	Estimated Inflow from Direct Connections (mgd)
Eastgate Project Area			
BEL011	4	4	0.049
BEL012	9	3	0.030
BEL014	7	5	0.043
BEL031	6	2	0.063
BEL032	7	1	0.019
Issaquah Project Area			
ISS003	3	3	0.013
ISS004	0	0	0
Renton Project Area			
RNT005	7	7	n/a[b]
Skyway Project Area			
BLS001	34	13	0.0745
BLS002	72	32	0.2537
BLS003	21	8	0.0608

a. Total observed smoke leaks include direct inflow connections and sewer system defects, as defined in Section 2.4.1.
b. Inflow volume not calculated for Mini-Basin RNT005 because none of the observed smoke leaks were in areas where inflow would be considered a problem.

2.6 SSES RESULTS AND CONCLUSIONS

The findings of the SSES, together with the results of King County's 2003 I/I pilot project, established some basic understandings to be used in developing and evaluating initial I/I reduction alternatives. Some of the findings relate to all project areas investigated; others are specific to individual project areas or mini-basins. The following sections describe the essential results and conclusions of the SSES.

2.6.1 Spreadsheet Summary of Findings

A "pipe summary" spreadsheet was created to summarize all the data on sewer mains, laterals and side sewers obtained during the SSES work. Each row of the spreadsheet presents the data for a single mainline run investigated in the SSES work, including data on the laterals and side sewers discharging to that section of sewer main. This spreadsheet provides a single location for the key information obtained during the SSES and helps to indicate patterns in the collected data. For example, it contains a column that indicates the number of laterals with defects along each sewer main, and a review of this column for Eastgate Mini-Basin BEL011 shows a fairly uniform distribution across the mini-basin, indicating that there is no localized area of deficiency in the system.

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Eastgate_ProjectArea_SmokeTest.mxd - peter keum
Data Source: King County

Figure 2 -12
Eastgate Project Area
Smoke Test Results
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Skyway_ProjectArea_SmokeTest.mxd - peter keum
Data Source: King County

Figure 2 - 13
Skyway Project Area
Smoking Test Results
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Renton_wetlandSites.mxd - peter keum
Data Source: King County

Figure 2 - 14
Wetland Site of Renton Project Area Field Visit
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

2.6.2 Focus on Laterals and Side Sewers

The pilot projects, the SSES and the flow monitoring results generally confirmed the conventional wisdom that laterals and side sewers represent the major source of I/I in a system. In instances where sewer mains are a considerable source of I/I, CCTV work often revealed clear evidence of this in the form of extensive and obvious structural and joint problems. Although CCTV inspections generally cannot directly identify I/I sources in side sewers and laterals, due to the camera's limited access to these sewers and to the physical characteristics of the side piping, CCTV inspection can identify side sewers and laterals that are made of concrete and clay piping, which are typically susceptible to cracks and leaks that lead to I/I. The SSES and the pilot projects both found the same general conditions present in much of evaluated area: structurally sound, well jointed sewer mains with concrete and clay tile laterals and side sewers; except in Skyway, where mains are in poor condition and contribute significantly to I/I.

Another indication that laterals and side sewers are the primary I/I sources in the project areas is the fast I/I response to rainfall observed in the flow monitoring conducted for this project. Because laterals and side sewers are buried at shallow depths, I/I that enters them tends to appear quickly after a storm event begins, and subside quickly after the rainfall stops. This fast response was observed in the flow monitoring results. When I/I enters through sewer mains, which are buried deeper, it is generally attributable to the rise in groundwater, which lags behind the beginning of the storm event. The flow monitoring results did not indicate this type of slow, groundwater-based response.

These conditions suggest that most of the I/I comes from laterals and side sewers, so rehabilitation of laterals and side sewers, rather than sewer mains, is the focus of alternatives developed for the initial I/I reduction projects.

2.6.3 Distribution of I/I Within Mini-Basins

The SSES analyses did not show any great variety within individual mini-basins in the distribution of sewer defects that are the likely sources of I/I. Therefore, it is likely that I/I enters the system in a generally uniform way across each mini-basin. Inflow sources identified by smoke testing are exceptions to this uniform allocation because they are specific entry points for stormwater flows. Thus, I/I quantities can be evenly distributed across the parcels in each mini-basin as follows:

- Estimated flow rates for all inflow sources in the mini-basin are subtracted from the total estimated I/I quantity.
- The I/I remaining after removal of inflow is divided by the number of parcels actually served by the sewer system, providing an anticipated amount of I/I that can be attributed to each parcel served. Parcels that are open space or are not served by the sewer system are not included in the allocation.

2.6.4 Appropriate Rehabilitation Technologies

During the pilot projects, it was found that pipe lining of lateral and side sewers can be effectively accomplished only in a narrow range of field conditions: single service side sewers (no branching lines), limited bends, and relatively short runs. When all of these conditions are not met, lining is difficult and often infeasible. The SSES found that the side sewers in the project areas usually fail to conform to at least one of these conditions. In Eastgate and Issaquah, most side sewers failed to meet even one of these conditions.

Successful lining of side sewers can be done, and there are many small contractors who perform the service. However, it is typically done one side sewer at a time and takes a highly experienced crew an

entire day to complete. Doing such work on the scale of a project area or mini-basin would likely be difficult to contract and execute in the local market.

Pipe bursting was also performed extensively in the pilot projects. While it does not have the same challenges as pipe lining, it has added costs, typically in the form of restoration and access costs. Pipe bursting involves more excavation, so there is also typically greater disruption to the homeowner. However, it can be used successfully in the most challenging of the project areas, and it has been performed successfully on many large-scale projects in the Northwest.

Based on consideration of these factors, it was determined that cost estimating for initial I/I reduction alternatives would be developed assuming pipe bursting as the rehabilitation technique.

2.6.5 Eastgate Mini-Basin BEL014

While all of the Eastgate mini-basins have some PVC laterals and side sewers, the City of Bellevue has indicated that Mini-Basin BEL014 is the only one with high percentages of PVC mains, laterals and side sewers. Only two likely sources of direct inflow were observed in Mini-Basin BEL014, and both of these are related to catch basins located in or directly adjacent to rights of way. These conditions led to reassessment of the need to include Mini-Basin BEL014 in further analysis and consideration. Mini-Basin BEL014 has the lowest potential I/I contribution of the five Eastgate mini-basins, at 0.56 mgd. If this I/I were equally distributed among the 225 properties in the mini-basin, the potential reduction associated with each property would be low. In addition, early field reviews indicated challenging site conditions in Mini-Basin BEL014, with very steep topography and long main runs located in easements and forested areas.

Due to these considerations, it was decided that Mini-Basin BEL014 would not likely prove to be cost-effective as a potential reduction project, and it was dropped from further consideration after the smoke testing work was completed.

2.6.6 Renton Project Area

Renton project area flow monitoring performed for this alternatives analysis did not indicate the level of I/I that had previously been measured or predicted by modeling for this project area. The reason for this change is not clear, but the Washington State Department of Transportation recently completed work on the SR-167 on-ramp adjacent to the wetland area where a field visit indicated inflow through submerged manhole covers. It is possible that construction resulted in changes to the surface water drainage patterns. The work may have resulted in a diversion of surface water away from the sewer line in the wetland area, which could have changed or reduced the tendency for inflow into the sewer system.

Given the current levels of measured I/I in the mini-basin, it does not appear that rehabilitation in the mini-basin will meet the cost-effectiveness criteria established for this project. At the April 16, 2008 E&P Subcommittee meeting, a decision was made to remove the Renton project area from further consideration of large-scale rehabilitation under the Initial I/I Reduction project.

2.6.7 System Map Development and Review

Maps of the existing sewer system in the project areas were developed from sewer system information provided by each local agency and property information from King County databases. The sewer system information available varied from agency to agency, but in general consisted of side sewer record drawings, geographical information system data, and CAD system inventory drawings. King County property information consisted of property lines, rights of ways, and aerial photography. These data

sources were reviewed and combined to produce system maps indicating main and side sewer locations, property lines and aerial imagery.

Once the system maps were developed, a review was conducted of the mapping information and the CCTV data. This review was intended to provide a general sense of the accuracy of the system mapping data and to identify areas where mapping may have recorded incorrect information or where there are gaps in the CCTV data. The CCTV reports and video provided accurate locations of all side sewer connections on the mains, and these were compared to approximate locations indicated on the mapping information.

In several cases, it was discovered that the number of side sewer connections recorded in the CCTV analysis did not correspond with the information on the mapping data. Typically these discrepancies consisted of the CCTV work indicating fewer taps than shown on the system maps, which generally indicates shared laterals. In these locations, CCTV side sewer records were then reviewed to attempt to confirm if a shared side sewer existed. In many cases, it was difficult to make this final determination, as side sewer lengths prevented the side launch camera from reaching individual side sewer branches. However, these long lengths, combined with sewer main data documenting fewer service taps than the number of properties served by the main, were interpreted to indicate shared side sewers.

CHAPTER 3.
GEOTECHNICAL, GROUNDWATER AND ENVIRONMENTAL EVALUATIONS

Based on the SSES findings, the Renton project area was removed from further detailed analysis for I/I reduction. The Eastgate, Issaquah and Skyway project areas were further evaluated for general conditions pertinent to consideration of I/I reduction projects in *King County Inflow & Infiltration Project Study Environmental Technical Memorandum* (Shannon & Wilson, 2007), which is included in Appendix A of this alternatives analysis report. The findings of these further evaluations are summarized in this chapter.

3.1 LANDSLIDES AND EROSION

3.1.1 Geological Conditions

Eastgate

Most of the Eastgate project area lies on the north-facing slope of Bellevue's Newcastle Hills near the southwestern corner of Lake Sammamish. This north-facing slope consists of several ridges separated by three prominent, steep-sided, north-oriented drainages. In general, slopes on the ridges range from 15 to 50 percent while the slopes within the ravines range from 45 percent to steeper than 110 percent.

The project area is underlain by Pleistocene glacial soils and Tertiary bedrock. The primary surface deposit is Vashon Till, a very dense, gray, gravelly silty sand that is commonly referred to as "hardpan." Vashon glacial recessional deposits, consisting of normally consolidated, stratified sand and gravel with variable amounts of interbedded fine-grained silt and clay, exist along the lower portions of the project area. The Vashon recessional deposits range in density from loose to dense and from very soft to stiff. Many of the steep slopes in the project area have been modified by residential housing construction, street grading, and park development.

Issaquah

Nearly the entire Issaquah project area is on the lower portions of the east-facing slope of Squak Mountain west of the Issaquah city center. Relatively flat topography of the Issaquah Creek alluvial plain characterizes the eastern portion of the project area. Several east-oriented tributary drainages to Issaquah Creek, separated by several prominent, steep-sided ridges, characterize the project area topography. In general, slope inclinations on the ridges range from 15 to 60 percent, while the slopes within the ravines range from 65 to steeper than 100 percent.

The project area is underlain by Pleistocene glacial soils and Tertiary bedrock. Glacially consolidated soils consisting of Vashon till and Vashon advance outwash mantle most of the slope in the northern portion of the project area. Older, pre Vashon, fine-grained deposits of silt and clay underlie the advance outwash sand and gravel near the toe of the east-facing slope at the northern and southern portions of the project area. Soils within the relatively flat floodplain of Issaquah Creek in the eastern portion of mini-basin ISS004 include fill soils overlying alluvium, with groundwater depths as shallow as 4 feet below ground surface.

Intensive underground coal mining in the late 19th and early 20th centuries occurred in the southern portion of the project area, in the vicinity of Wildwood Boulevard SW. Coal mine related subsidence features have been documented in several reports and newspaper articles. Elsewhere in the project area,

many of the steep slopes have been modified by residential housing construction, street grading, and park development.

Skyway

The Skyway project area is located on an upland plateau that overlooks Lake Washington. The ground surface is gently sloping, from 0 to 20 percent. Steep slopes (greater than 40 percent) exist in and adjacent to the western and eastern portions of Mini-Basin BLS001, within the creek ravines at the north and south margins of Mini-Basin BLS002, and within the Bryn Mawr Park area of Mini-Basin BLS003.

Vashon till underlies most of the Skyway project area. Glacial recessional, normally consolidated soils are mapped on top of the till in several locations. Older, pre-Vashon glacial and interglacial deposits underlying the Vashon till are exposed along the steep valley walls of Taylor Creek.

Bedrock of the Tukwila Formation underlies the glacial soils in the project area. Bedrock exposures were observed during field reconnaissance on the steep, east-facing slopes of the Bryn Mawr Park area in BLS003 and along the western margin of BLS001.

3.1.2 Potential Slope Stability Issues

Eastgate

King County and City of Bellevue critical-area maps identify landslide hazard areas in the Eastgate project area at the following locations:

- Between SE Newport Way and SE 44th Place (Mini-Basin BEL012)
- Between SE 43rd Place and SE 44th Place (Mini-Basin BEL012)
- East of 158th Place SE (Mini-Basin BEL012)
- West of 158th Avenue SE (Mini-Basin BEL011)
- South of SE 50th Street (Mini-Basin BEL011)
- East of the SE 46th Way and 159th Avenue SE intersection (Mini-Basin BEL011)

Erosion hazard areas are generally confined to the Vasa Creek ravine and the northeast-trending ravine to the east in Mini-Basin BEL012. Portions of the area underlain by Vashon recessional soils in the Eastgate Park area in Mini-Basin BEL032 are also classified as an erosion hazard area.

The mapped erosion and landslide hazard areas are generally consistent with field observations performed for the alternatives analysis. However, steep slope hazard areas consisting of slopes of 40 percent or greater are not mapped and are ubiquitous throughout the project area.

No coal mine or seismic hazard areas are indicated on King County or City of Bellevue maps of the project area.

The potential for inducing landslides or erosion in most of the Eastgate project area is low to negligible. However, improvements to reduce I/I could cause groundwater levels to rise, thereby increasing the risk of landslides. The ground surface around maintenance holes located in steep, undeveloped rights-of-way could be disturbed during construction, which could cause erosion if construction best management practices are not followed.

Issaquah

The entire Issaquah project area is situated within Issaquah city limits, and the City of Issaquah does not currently have citywide critical areas maps. Erosion hazard areas regulated by the City of Issaquah consist of areas mapped by the Natural Resource Conservation Service (NRCS) as having a "severe" or "very severe" erosion hazard. Based on the NRCS soils map of the project area, erosion hazards exist along portions of Sunrise Place SE, Mount Quay Drive SW, the steep east-facing slope west of Newport Way NW, and in the vicinity of Mount Defiance Circle SW.

Steep slope hazard areas, as defined by slopes of 40 percent or greater, are present throughout the Issaquah project area.

The entire Issaquah project area south of Mountain Park Boulevard SW is classified as a coal mine hazard area. No seismic hazard areas are indicated on the King County Sensitive Areas maps within the Issaquah project area. However, portions of the project area situated within the Issaquah Creek alluvial plain could be considered seismically hazardous.

The potential for inducing landsliding or erosion in most of the Issaquah project area is low to negligible. However, in some areas the potential could be moderate to high if I/I is currently being directed into sewer lines in the following areas:

- The bowl area northeast of West Sunset Way, in the vicinity of Sunset Court NW (Mini-Basin ISS004)
- The bowl area between the Almak Court NW and Dorado Drive NW dead ends (Mini-Basin ISS004)
- The Mount Quay Drive NW area of historical instability (Mini-Basin ISS004)
- The bowl area between Mount Defiance Circle NW and SW Mount Baker Drive (Mini-Basins ISS003 and ISS004)
- The area east of Wildwood Boulevard SW between SW Clark Street and Sunrise Place SW (Mini-Basin ISS003)

Improvements to reduce I/I could cause groundwater levels to rise, thereby increasing the risk of landslides. The ground surface around maintenance holes located in steep, undeveloped rights-of-way could be disturbed during construction, which could cause erosion if construction best management practices are not followed.

Skyway

King County and City of Renton critical-area maps identify landslide hazard areas in the Skyway project area at the following locations:

- Adjacent to Taylor Creek, west of Rustic Road South (BLS002)
- Upslope and downslope of Raymond Place NW (BLS001)
- East of 87th Avenue South along the slope adjacent to Rainier Avenue South (BLS001).

Mapped erosion hazard areas are generally adjacent to and/or coincident with the landslide hazard areas in Mini-Basin BLS001. Areas of observed instability that are not currently mapped by local jurisdictions within geologically hazardous are as follows:

- The steep slope between South 123rd and South 124th Streets east of 81st Place South (BLS001)

- The steep slope between South 120th and South 122nd Streets west of 82nd Avenue South (BLS001)
- The ravine slopes along Stream 1 (BLS002)
- The east-facing slope below Garden Place South along Rainier Avenue South (BLS002)
- The east-facing slopes located east of 80th Avenue South, between South 120th and South 123rd Streets (BLS003)

The potential for inducing landsliding or erosion in most of the Skyway project area is low to negligible. However, in some areas the potential could be moderate to high if I/I is currently being directed into sewer lines in the following areas:

- The slope above Rainier Avenue South east of South 121st and NW 7th Streets (easternmost portion of BLS001)
- The slope east of 84th Avenue South in the vicinity of Raymond Place NW (BLS001)
- The slope between South 123rd and South 124th Streets east of 81st Place South (eastern portion of BLS001)
- The slopes located between South 120th and South 122nd Streets west of 82nd Avenue South (eastern portion of BLS001)
- The east-facing slopes located east of 80th Avenue South, between South 120th and South 123rd Streets (BLS003)
- The slopes north of South Sunnycrest Road, between Cornell Avenue South and Crestwood Drive South (BLS002)
- The west-facing slope adjacent to the houses along Rustic Road South and Crestwood Drive South, between house nos. 10619 Rustic Road South and 11033 Crestwood Drive South (BLS002)
- In the vicinity of the steep-sided depression, approximately 200 feet south and 200 feet north of house no. 10800 Forest Avenue South (BLS002)
- The slope between Garden Place South and Rainier Avenue South, from South Lakeridge Drive, north to the Garden Place South cul-de-sac (BLS002)
- The Stream 1 ravine slopes between 81st and 82nd Avenues South, and between Lotus Place South and 84th Avenue South (BLS002).

Improvements to reduce I/I could cause groundwater levels to rise, thereby increasing the risk of landslides. The ground surface around maintenance holes located in steep, undeveloped rights-of-way could be disturbed during construction, which could cause erosion if construction best management practices are not followed.

3.2 GROUNDWATER

3.2.1 Groundwater Conditions

Eastgate

Many residences in the Eastgate project area have drains from their property through the sidewalk that discharge into the street. Some of these drains direct up to 1 gallon per minute of groundwater off the subject properties into storm drains. These drains are an indication of shallow groundwater, as well as groundwater inflow into the sewer system. However, the project area does not have a significant shallow

groundwater table within the glacial till areas in the upland sections. Most seeps in the project area come from areas of colluvium at steep slopes, with the water likely perching on less permeable bedrock or glacial till. Pockets of coarse-grained soils in the glacial till could contribute to small amounts of groundwater. In general, shallow groundwater follows the surface topography, flowing to the north toward Lake Sammamish and Lake Washington.

No specific water-level fluctuation data were identified but based on experience in similar locations, groundwater in recessional outwash in the project area could fluctuate seasonally in relation to surface water features and rainfall. Also, groundwater may perch on top of the glacial till. The amount of perched water likely would fluctuate seasonally, with less water present during the summer and fall and more water present during the winter and spring.

Issaquah

Issaquah is located in the Issaquah Creek Valley groundwater management area (KCDNR, 1998). East of Newport Way NW, the Issaquah project area is located in a wellhead protection area. Areas in Mini-Basin ISS004, around Big Bear Place NW and Mount Fury Circle SW, are mapped as having a medium susceptibility to groundwater contamination (King County, 2007b).

Stormwater ditches with standing water were found in Mini-Basin ISS003 on Mt. Defiance Circle SW, SW Mt. Baker Drive, and Hillside Drive SE, indicating a potential impact on shallow groundwater through water infiltration. Groundwater seeps, indicating perched or shallow groundwater, were found in abundance in the northwestern end of Mini-Basin ISS004 and off Mount Park Boulevard SW and Mount Defiance Circle SW in Mini-Basin ISS003. Minor seeps in the southern end of Mini-Basin ISS003 were found emerging from the slope along Hillside Drive SE.

In general, groundwater flows with topography to the northwest, toward Lake Sammamish. No specific water-level fluctuation data were identified, but groundwater perching on low-permeability soil would likely fluctuate seasonally, with less water present during the summer and fall and more water present during the winter and spring. Groundwater in the alluvium deposits would likely fluctuate seasonally in direct relationship to the elevation of Issaquah Creek.

Skyway

The southeastern end of Mini-Basin BLS002 is in a wellhead protection area, near the Oakwood Ave South and South Lakeridge Drive intersection. Mini-Basins BLS001 and BLS003 are in a wellhead protection area, centered around the community water source wells at 78th Ave South and South 116th Street.

All three Skyway mini-basins have scattered, open stormwater ditches with standing water, indicating that the area has a high groundwater table. In general, where glacial till is present, relatively low volumes of groundwater would likely occur because of the low permeability of the till. At the western edge of Mini-Basin BLS002, more groundwater might be encountered, depending on the extent of the recessional outwash sand deposits into the project area.

In general, shallow groundwater that perches on top of the glacial till likely follows the surface topography, flowing downhill to the north, toward Lake Washington. In Mini-Basin BLS001, water may flow eastward as well, toward the Cedar River. No specific water-level fluctuation data were identified, but groundwater perching on low-permeability soil would likely fluctuate seasonally, with less water present during the summer and fall and more water present during the winter and spring.

3.2.2 Potential Groundwater Issues

Eastgate

Significant volumes of groundwater may be found in Mini-Basin BEL012 in the vicinity of sewer lines and manholes along the northern part of the Eastgate project area in the recessional outwash deposits. Excavation in these sand and gravel areas may require dewatering to control groundwater inflow. Pipe-bursting activity could cause groundwater pressures to rise around the bursting head, making the saturated soils more fluid. In this area, construction methods used in pipe bursting should control soil brought by groundwater inflow between the burst and replacement pipes, to prevent locking of the pipes during installation.

Lesser accumulations of groundwater could perch atop glacial till or exist within coarse-grained lenses in the till. Groundwater in glacial till areas could contribute to sewer infiltration but likely does not pose significant problems during excavation activities.

Basins BEL031, BEL032 and BEL012 have potential stormwater infiltration or retention areas. Through infiltration, there is a potential for increased groundwater in these areas, which could result in a need for limited construction dewatering. Open ditches with standing water in Mini-Basins BEL031 and BEL012 indicate that these areas have a high groundwater table, which could result in a need for limited construction dewatering.

The presence of a wellhead protection area between Mini-Basins BEL031 and BEL011 may require coordination with regulatory agencies for the proposed project. The King County Department of Health is responsible for the wellhead protection area. Notification prior to work in the area is recommended and the use of BMPs may be required to protect groundwater resources.

Issaquah

Significant amounts of groundwater could be encountered near Issaquah Creek in both Issaquah mini-basins, and excavation activities in the area could require construction dewatering to control groundwater inflow. Pipe-bursting activity could cause groundwater pressures to rise around the bursting head, making the saturated soils more fluid. In this area, construction methods used in pipe bursting should control soil brought by groundwater inflow between the burst and replacement pipes, to prevent locking of the pipes during installation.

Groundwater could be present in significant amounts in glacial advanced outwash deposits in the northwestern part of Mini-Basin ISS004. Groundwater in the deposits might need to be controlled with dewatering activity around pits associated with pipe-bursting activities. Construction methods should also control soil and groundwater inflow between pipes during construction.

In the mine-altered ground found in Mini-Basin ISS003, excavation activities could require limited to significant dewatering activities because of the variable nature of the backfill.

With both Issaquah project area mini-basins being located in a groundwater management area, and with the presence of a wellhead protection area east of Newport Way NW in Mini-Basin ISS004, coordination with local regulatory agencies could be necessary. King County and the City of Issaquah regulate the groundwater management area, and the King County Department of Health is responsible for the wetland protection area. In both cases, notification is required for work in both areas and the use of BMPs may be required to protect groundwater resources.

Skyway

Small accumulations of groundwater could perch atop glacial till or exist within coarse-grained lenses in till in the Skyway project area. Groundwater in these areas may seasonally contribute to sewer infiltration, but likely would not pose significant problems during excavation. Only limited construction dewatering may be necessary in the vicinity of pits for pipe-bursting activity. Groundwater seeps could be captured or diverted to reduce construction impacts.

Greater amounts of groundwater may be encountered in the western part of Mini-Basin BLS002, near the occurrence of sandy, advanced outwash soils. Excavation activities for pipe-bursting pits in these sand areas may require construction dewatering to control groundwater inflow into pipe-bursting pits. Pipe-bursting activity could cause groundwater pressures to rise around the bursting head, making the saturated soils more fluid. In this area, construction methods used in pipe bursting should control soil brought by groundwater inflow between the burst and replacement pipes, to prevent locking of the pipes during installation.

The presence of a wellhead protection area in the project area may require coordination with regulatory agencies. The King County Department of Health is responsible for the wetland protection area. Notification prior to work in the area is recommended and the use of BMPs may be required to protect groundwater resources.

3.3 IDENTIFICATION OF WETLANDS, STREAMS AND WILDLIFE

Wetlands, streams and wildlife were identified through a document review and site reconnaissance for each project area. The complete report of the identification study (Shannon & Wilson, 2007) is included in Appendix A of this alternatives analysis report and summarized below.

3.3.1 Eastgate

A document review identified the following resources in the Eastgate project area:

- **Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species Map**—Two priority habitats associated with Eastgate Park in Mini-Basin BEL032 are designated as urban natural open space. One priority habitat, containing two steep, wooded, riparian ravines that extend south from Eastgate Park in Mini-Basin BEL032, is designated as a riparian zone. No priority species are mapped in the project area.
- **Washington Department of Natural Resources (WDNR) Natural Heritage Information System Database**—No records for rare plant or high quality ecosystems are identified in the project area.
- **WDNR Forest Practices Application Review System**—Sunset Creek in Mini-Basin BEL032 and Vasa Creek in Mini-Basin BEL012 (also known as Squibbs Creek) are mapped as type F (fish-bearing) waters. A tributary to Vasa Creek in Mini-Basins BEL011 and BEL012 and an unnamed stream in the eastern project portion of Mini-Basin BEL012 are mapped as type N (non-fish-bearing) waters.
- **King County Critical Areas Map**—Vasa Creek and an unnamed stream that crosses SE 43rd Street southeast of 164th Way SE in Mini-Basin BEL012 are tributaries to Lake Sammamish. Sunset Creek flows north to Richards Creek. North of the project area and downstream of I-90, Vasa Creek and Sunset Creek are mapped as Class 2 Salmonid streams. No wetlands are mapped in the project area. No portion of the King County Wildlife Network is mapped in the project area.

A site reconnaissance on March 3 and 4, 2008 identified six wetlands in the project area:

- Wetlands A, B and D in Mini-Basin BEL012
- Wetland C in Mini-Basin BEL011
- Wetland E in Mini-Basin BEL031
- Wetland F in Mini-Basins BEL031 and BEL032.

Wetlands A, B, and C are forested/scrub/shrub riparian systems associated with site streams. Wetlands D, E, and F are palustrine forested/scrub/shrub systems. Wetland F is likely a stormwater detention pond and may not be subject to wetland regulations.

The City of Bellevue has jurisdiction over Wetlands A, B, C, and D. The Bellevue Municipal Code requires wetland buffer widths ranging from 40 to 225 feet, or as established through a previously approved and recorded Native Growth Protection Area (NGPA) or Native Growth Protection Easement (NGPE). Wetlands E and F are located in unincorporated King County and are subject to King County's buffer requirements. Under King County code, Wetlands E and F would be subject to buffer widths ranging from 50 to 225 feet.

No areas were observed that would be regulated as habitats associated with species of local importance (under LUC 20.25H.150) or as a Wildlife Habitat Conservation area (under King County Code 21A.24.382).

Within the project area, Vasa Creek, the east tributary to Vasa Creek, and Sunset Creek fall under the City of Bellevue's jurisdiction. For Type N waters, the City of Bellevue code requires a 50-foot buffer on undeveloped sites (i.e., sites that do not contain a primary structure). For developed sites (i.e., sites with an existing primary structure), the City of Bellevue code requires a 25-foot buffer or a buffer width as established with the existing NGPA or NGPE, whichever is greater.

The unnamed stream that crosses SE 43rd Street is located in unincorporated King County and is subject to King County's buffer requirements. King County's buffer requirements will need to be met for all site streams within King County. King County requires a 65-foot buffer for Type N waters. The classifications and buffer widths for the site streams are summarized in Table 5 of Appendix A.

3.3.2 Issaquah

A document review identified the following resources in the Issaquah project area:

- **Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species Map**—The PHS maps show wetlands associated with Issaquah Creek south of Newport Way SW in Mini-Basin ISS003 and three wetlands associated with fish hatchery ponds northeast of Newport Way SW and between West Sunset Way and Front Street South in Mini-Basin ISS004. Priority anadromous and resident fish include fall Chinook salmon, coho salmon, sockeye salmon, winter steelhead, coastal cutthroat trout, and kokanee salmon in Issaquah Creek, and coho salmon and resident coastal cutthroat trout in an unnamed stream.
- **Washington Department of Natural Resources (WDNR) Natural Heritage Information System Database**—No records for rare plant or high quality ecosystems are identified in the project area.
- **WDNR Forest Practices Application Review System**—Issaquah Creek, which parallels the east sides of Mini-Basins ISS003 and ISS004, is mapped as a Type S water. Eight tributaries to Issaquah Creek are classified as Type F or Type N waters.

- **King County Critical Areas Map**—Issaquah Creek is mapped as a Class 2 Salmonid stream and four unclassified tributaries to Issaquah Creek are mapped in the project area. No wetlands are mapped in the project area. No portion of the King County Wildlife Network is mapped in the project area.
- **City of Issaquah Stream Inventory and Habitat Evaluation Report**—Issaquah Creek is rated as a Class 1 stream and seven smaller streams in the project area are mapped as Class 2, Class 2 with Salmonids, or Class 3 streams. Four wetlands associated with Issaquah Creek are mapped in the project area. Fall Chinook salmon, coho salmon, sockeye salmon, winter steelhead, coastal cutthroat trout, and kokanee salmon are reported in Issaquah Creek. Cutthroat trout presence is reported in two other streams in the project area

A site reconnaissance on March 4, 2008 identified several wetlands in Mini-Basin ISS003, including forested riparian wetlands associated with Issaquah Creek, riparian scrub/shrub wetlands associated with three tributary streams, and a forested/scrub/shrub wetland near the convergence of Issaquah Creek and its east fork.

Issaquah's municipal code requires that wetland buffer widths range from 40 to 225 feet. Issaquah does not have specific regulations regarding wildlife habitat conservation areas. Issaquah's buffer width requirements are 100 feet for Class 1 and Class 2S streams, 75 feet for Class 2 streams, 50 feet for Class 3 streams, and 25 feet for Class 4 streams.

3.3.3 Skyway

A document review identified the following resources in the Skyway project area:

- **Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species Map**—Two priority habitats, designated as "Urban Natural Open Space," are mapped in Mini-Basin BLS002. Two bald eagle nest sites, identified in 2006, are mapped in or near the project area. Northern portions of Mini-Basin BLS002 fall within the mapped bald eagle 800-foot and shoreline nest buffer.
- **Washington Department of Natural Resources (WDNR) Natural Heritage Information System Database**—No records for rare plant or high quality ecosystems are identified in the project area.
- **WDNR Forest Practices Application Review System**—An unnamed stream in Mini-Basin BLS002, identified as Stream 1, is mapped as a Type N stream (for the upper 400 feet) and as a Type F stream. Taylor Creek, to the west of Mini-Basin BLS002, is mapped as a Type F stream. No wetlands were mapped in the project area.
- **King County Critical Areas Map**—Three unclassified streams are mapped: Taylor Creek, Stream 1, and a tributary to Stream 1 in Mini-Basin BLS003. No wetlands are mapped in the project area. No portion of the King County Wildlife Network is mapped in the project area.
- **King County Shoreline Management Program Map**—A narrow portion of Mini-Basin BLS002 along Rainier Avenue South is designated as urban shoreline environment.
- **City of Seattle Department of Planning and Development GIS**— A riparian corridor and wetland along a stream are shown along Taylor Creek at the western boundary of Mini-Basin BLS002. Wildlife areas are mapped along western and southwestern boundaries of Mini-Basin BLS002.

A site reconnaissance on March 3 and June 30, 2008 identified three wetlands: a scrub/shrub system within the ravine east of 76th Avenue South and south of South 116th Street in Mini-Basin BLS003; a

small scrub/shrub system associated with Stream 2 in Mini-Basin BLS001; and a small forested/scrub/shrub system on a vacated segment of the South 123rd Street right-of-way west of 85th Avenue South in Mini-Basin BLS001.

I/I reduction projects likely would qualify as exempt from shoreline substantial development permit requirements as they are normal maintenance or repair of existing structures or developments. Shoreline exemptions can be approved by King County.

King County code requires wetland buffer widths ranging from 50 to 225 feet. King County also requires 25-foot buffers for Type O streams, 65-foot buffers for Type N streams and 115-foot buffers for Type F streams. Taylor Creek is approximately 60 feet west of the project area boundary, but its associated buffer would likely overlap the project area.

County, state and federal regulations establish restrictions on activities within define distances from active bald eagle nests.

3.4 HAZARDOUS MATERIALS EVALUATION

An evaluation was conducted to determine if hazardous materials are likely to be encountered during the I/I reduction projects. The complete report of the evaluation (Shannon & Wilson, 2007) is included in Appendix A of this alternatives analysis report and summarized below.

Properties were ranked "low," "moderate," or "high" based on the likelihood of contaminants to be present in the soil in the vicinity of the sewer line and manholes. Properties with known groundwater or soil contamination located near or adjacent to the sewer are rated "high." Properties where spills have been reported or where there are no known releases but where businesses using hazardous materials are or previously were present (e.g. older gas stations, older automobile repair shops, dry cleaners, print shops) are rated "moderate." Other businesses—including gas stations and automobile repair shops developed since 1988 and construction companies with no known underground storage tanks—and residences with heating oil tanks are considered to have a low potential for contamination.

The potential for impact on the sewer line from contaminated sites was evaluated based on the type of business, the proximity of the parcel to the sewer line, and the known or suspected presence of contaminants. In areas where the water table is at or above the sewer pipe elevation, the potential exists that the sewer trench backfill could be serving as a hydraulic conduit for contaminated groundwater migration. In such cases, groundwater could carry contamination for considerable distances along the sewer line corridor. Excavation and dewatering practices used during sewer line repair activities could create or modify contaminant migration pathways and/or distribution.

The toxicity and cost of remediating contaminated soil that could be encountered during sewer line improvements varies depending on the type of contaminant. For example, dry cleaning solvents are highly toxic at low concentrations, and remediation costs are typically very high. Other solvent contaminants resulting from businesses such as photo processing or printing shops may be less toxic than dry cleaning solvents, but they can also result in high remediation costs. Soils contaminated with gasoline-range petroleum hydrocarbons generally have a lower toxicity and a lower disposal cost than soils contaminated with solvents. Older gasoline tends to be less toxic and somewhat less expensive to remediate. Diesel- and oil-range petroleum hydrocarbons are the least toxic and least mobile petroleum contaminants and typically have the lowest cleanup costs. Metal contaminants could result in high remediation costs, but they have a relatively low health risk unless they are ingested.

Construction monitoring should be performed where excavation is planned in areas of low potential for impact from contaminated sites (such as where spills have occurred and where underground storage tanks are suspected to be present). If contamination is identified, it would then be necessary to provide appropriate health and safety measures to protect site workers and to analyze the soil for proper disposal. Hazardous household materials such as cleaners, paints, and solvents are often disposed of in the sanitary sewer system from residences and businesses such as paint shops, printers, and photo developers. These materials can leak into the soil through sewer line joints. Sediments should be removed from manholes prior to work within them to reduce the risk of exposure to hazardous materials for site workers.

Based on the potential health risks associated with contaminated soil and groundwater, earthwork should be avoided in the vicinity of moderate and high risk sites. If earthwork cannot be avoided, a Phase II Environmental Site Assessment should be performed to determine whether contamination is present and to analyze the soil and groundwater for health and safety measures and proper disposal. The Phase II explorations should be confined to soil and/or groundwater sampling in the sewer line easement adjacent to each site.

Tables 3-1 through 3-3 summarize specific parcel ratings for hazardous materials in the Eastgate, Issaquah and Skyway project areas, respectively.

3.5 GEOTECHNICAL, GROUNDWATER AND ENVIRONMENTAL CONCLUSIONS

Although geotechnical, groundwater and environmental conditions were found to vary widely across the project areas, no conditions were found that pose significant issues for potential rehabilitation projects.

Potential groundwater, geotechnical and slope stability issues are generally limited to undeveloped portions of the project areas. Due to the highly variable nature of subsurface conditions, impacts of a potential rehabilitation project can only be estimated and judged in a broad qualitative fashion unless extensive studies are performed. While the potential for increased sloughing and erosion is always present if additional water is conveyed through the soil, areas susceptible to these mechanisms are limited within the project mini-basins.

Areas of recorded hazardous material concern are almost uniformly found to have minimal potential for influence by any potential rehabilitation project. The main potential for project impacts associated with hazardous materials is the possibility of construction cost impacts related to the discovery of residential heating oil tanks and associated soils.

TABLE 3-1.
EASTGATE PROPERTIES OF CONCERN FOR HAZARDOUS MATERIALS

Property	Location (Mini-Basin)	Contaminants of Concern
Low Risk		
Residences with heating oil	Various	Petroleum products
SPU Eastside Reservoir	4404 146th Avenue SE (BEL032)	Unknown
Hotel	15805 SE 37th Street (BEL012)	Petroleum products
Washington Environmental Pro T	4017 162nd Avenue SE (BEL012)	Unknown
Comcast Cable Communications Bellevue	3622 156th Avenue SE (BEL012)	Unknown
Arrow Lumber	16343 SE 40th Street (BEL012)	Petroleum products
5101 145th Place SE	5101 145th Place SE (BEL031)	Petroleum products
Theil Collins Residence	5215 146th Avenue SE (BEL 031)	Petroleum products
76 Gas Station/ Tosco Corp. Site 2564273	15220 SE 37th Street (BEL012)	Petroleum products
Schuck's Auto Supply	15303 SE 37th Street (BEL012)	Petroleum products
South Bellevue Community Center	14509 SE Newport Way (BEL032)	Petroleum products
Moderate Risk		
Eastgate Plaza Custom Cleaner	15220 SE 38th Place (BEL012)	Solvents
Hewlett-Packard Company	15815 SE 37th Street (BEL012	Petroleum products, metals

TABLE 3-2.
ISSAQUAH PROPERTIES OF CONCERN FOR HAZARDOUS MATERIALS

Property	Location (Mini-Basin)	Contaminants of Concern
Low Risk		
Residences with Heating Oil	Various	Petroleum products
660 Wildwood Boulevard	660 Wildwood Boulevard SW (ISS003)	Unknown
18 Mt. Pilchuck Avenue NW	18 Mount Pilchuck Avenue NW (ISS004)	Sewage sludge
Fish Hatchery Maintenance Garage	120 Newport Way SW (ISS003)	Petroleum products
Moderate Risk		
Puget Sound Energy Substation	NW of the Newport Way SW/ West Sunset Way intersection (ISS004)	Polychlorinated biphenyls
King County Fire District 10 Station	175 Newport Way NW (ISS004)	Petroleum products
Gilman Meadows Apartments	360 NW Dogwood Street (ISS004)	Unknown spilled material: screen for petroleum products, volatiles, pesticides
High Risk		
Former Gasoline Station	South of the Newport Way SW/ West Sunset Way intersection (ISS003)	Petroleum products

TABLE 3-3.
SKYWAY PROPERTIES OF CONCERN FOR HAZARDOUS MATERIALS

Property	Location (Mini-Basin)	Contaminants of Concern
Low Risk		
Residences with heating oil	Various	Petroleum products
8528 South 121st Street	8528 South 121st Street (BLS001)	Unknown
Renton Facilities and Operation Center/Site SE 11 Renton	12607 82nd Avenue South (BLS001)	Unknown
King County Fire District 20	11619 84th Avenue South (BLS003)	Petroleum products
Perovich & Son	12433 84th Avenue South (BLS001)	Petroleum products
S. 120th St. and 79th Ave. S.	S. 120th Street and 79th Avenue S. (BLS003)	Unknown
Bryn Mawr Lakeridge Water & Sewer District	7843 South 116th Street (BLS003)	Unknown
Moderate Risk		
11440 82nd Place South	11440 82nd Place South (BLS003)	Petroleum products
Former Lake Washington Greenhouses, Inc.	12167 87th Avenue South (BLS003)	Petroleum products, lead, pesticides, herbicides

CHAPTER 4.
DRAINAGE EVALUATIONS

I/I reduction activities have the potential to aggravate drainage problems that are caused by groundwater or by drainage systems with insufficient capacity. As improvements are made to prevent surface drainage or groundwater from entering the sewer system, flows that previously contributed to I/I can increase groundwater flows that cause drainage problems or lead to further exceeding the capacity of drainage infrastructure. In order that the potential for such problems be recognized in the development of I/I reduction projects, each project area was evaluated for records of existing drainage problems and complaints. This information will be used in project development so that steps can be taken to avoid any worsening of drainage problems resulting from the I/I reduction. This chapter describes the drainage problems that were identified in the evaluation.

4.1 EASTGATE

4.1.1 Existing Storm Drainage Infrastructure

In general, storm drainage in the Eastgate project area follows the topography, and systems drain from the south end toward the north. Three major ravines run north-south through the project area; depending on the topography, conveyance lines either discharge to these ravines within the limits of a mini-basin, or extend beyond the mini-basin limits and discharge to the ravine systems downstream. The westernmost ravine ultimately becomes Sunset Creek as it heads north. The easternmost ravine becomes Vasa Creek. Existing drainage infrastructure in the project area consists of a combination of public and private facilities.

Private elements of the system consist of roof downspout collection and conveyance lines, yard drains, wall and foundation drains, and driveway drains. There is little documentation of private drainage systems; the City of Bellevue does not maintain drawings of these elements.

Public storm drain collection and conveyance structures are primarily located within street rights of way, although portions are located in easements across private property. Based on City of Bellevue system inventory drawings, the following are the key elements of the existing public systems serving the Eastgate project area, beginning with the downstream end of each system:

- Two drainage systems serve Mini-Basin BEL032. The system that serves the northern half leaves the mini-basin and discharges to a ravine to the north. The system that serves the southern half conveys the flows for the majority of the mini-basin. Both systems consist of corrugated metal pipe and concrete pipe, 12 inches to 30 inches in diameter.
- Mini-Basin BEL012 is served by several small systems that discharge to a ravine along the west side of the mini-basin. These systems consist of corrugated metal pipe (CMP), PVC and concrete pipe, 8 inches to 18 inches in diameter.
- Mini-Basin BEL011 is served primarily by one system, which discharges to a ravine at the north end of the mini-basin. This system consists of CMP, PVC and concrete pipe, 8 inches to 30 inches in diameter.

4.1.2 Summary of Drainage Complaints

Drainage complaints for the Eastgate Project Area were obtained from City of Bellevue Maintenance and Operations staff. Table 4-1 identifies the complaints within the Eastgate mini-basins.

TABLE 4-1.
DRAINAGE COMPLAINTS AFFECTING I/I REDUCTION IMPROVEMENTS IN THE EASTGATE PROJECT AREA

	Number of Complaints				
	Broken / Inadequate Drainage System	Problem Due to Groundwater	Adjacent Property/ development	Road	Other complaints
Mini-Basin BEL011	1	4	0	10	0
Mini-Basin BEL012	5	3	6	8	5
Mini-Basin BEL014	3	3	1	3	2
Mini-Basin BEL031	3	4	3	2	3
Mini-Basin BEL032	3	1	4	3	1

4.2 ISSAQUAH

4.2.1 Existing Storm Drainage Infrastructure

Based on information provided by the City of Issaquah, Mini-Basins ISS003 and ISS004 both contain a fully developed drainage infrastructure consisting of a hard-piped conveyance system, with pipes made of a variety of pipe materials ranging and from 4 to 24 inches in diameters. The majority of the drainage system routes stormwater flows to the east, following the predominant slope of the area. Virtually all of the stormwater is eventually discharged to Issaquah Creek at locations along the eastern edge of the area.

4.2.2 Summary of Drainage Complaints

According to City of Issaquah staff, drainage complaints are rare and concern simple problems that are normally handled in the City's routine system maintenance program, such as catch basins occasionally blocked with leaves or debris.

4.3 SKYWAY

4.3.1 Existing Storm Drainage Infrastructure

The Skyway project area is in unincorporated King County, and the county owns and maintains the storm drainage infrastructure in the three study mini-basins. Stormwater collection and conveyance primarily consists of catch basins and storm drainage pipelines; however approximately 10 percent of the area includes open ditches and culverts.

The King County Roads Department has indicated that the storm drainage infrastructure in the Skyway project area has limited capacity, with capacity to convey flows up to a 10-year storm event.

4.3.2 Summary of Drainage Complaints

King County Interactive Mapping System

Drainage complaint maps by property were generated for the Skyway project area from data included in King County's Interactive Mapping System (IMAP), which provides such data for Skyway and other unincorporated areas of the county. Each complaint listing includes a complaint number, the date it was reported and closed, the address of the property, and comments relating to the complaint. In the IMAP data for Skyway, some properties have more than one drainage-related complaint. The complaints are categorized as follows, based on the source of the problem:

- Broken/Inadequate Drainage System—Complaints related to natural drainage blockage or broken or inadequate drainage systems
- Groundwater—Complaints related to groundwater impact on private property, such as subsurface flow creating ponding or wet backyards
- Adjacent Property/Development—Complaints related to runoff from adjacent properties, such as sheet flows from adjacent property or property impact from adjacent single family residential development
- Road—Complaints related to road runoff, such as sheet flow from roads and alleyways, offsite flows, road runoff bypassing a catch basin, or road runoff flowing into driveways
- Downspout—Complaints related to discharge of downspouts or footing drains over sidewalks
- Other Complaints—All other general complaints reported by the property owners.

Figure 4-1 shows the properties identified on IMAP as having reported drainage complaints over the past 30 years in the Skyway project area. Tables listing each complaint from 1977 to 2006 are included in Appendix B; this includes 65 properties in Mini-Basin BLS001, 58 properties in Mini-Basin BLS002, and 33 properties in Mini-Basin BLS003. Table 4-2 summarizes the number of complaints related to inadequate drainage systems and groundwater problems, which are the type of complaints that would be most likely to increase as a result of I/I rehabilitation.

TABLE 4-2.
DRAINAGE COMPLAINTS AFFECTING I/I REDUCTION IMPROVEMENTS IN THE SKYWAY PROJECT AREA

	Number of Complaints	
	Broken / Inadequate Drainage System	Problem Due to Groundwater
Mini-Basin BLS001	3	6
Mini-Basin BLS002	2	4
Mini-Basin BLS003	3	2

Skyway Water and Sewer District

Additional information on potential drainage problems in the Skyway project area was obtained from discussions with Skyway Water and Sewer District officials. Following the pilot project improvements of approximately 175 properties in Skyway, there were reports of drainage problems from four property owners. The property owners reported groundwater problems that resulted in wet backyards and surface ponding. The District investigated the reports and determined that the problems were the responsibility of

the property owners to fix. No project funds were used to remedy the drainage complaints. Surface ponding around a manhole also occurred following sewer main rehabilitation. The District remedied the problem by installing a subsurface drain to collect groundwater and convey it to a storm drainage pipeline. The work was added to the construction contract by change order.

4.4 DRAINAGE CONCLUSIONS

It is likely that instances of drainage-related problems will result from I/I reduction improvements. Based on previous history and anecdotal information provided by local agencies, the Skyway project area has the highest probability of experiencing such problems. Drainage problems resulting from increased groundwater volumes such as wet backyards and surface ponding have a moderate potential to occur. Storm drainage infrastructure capacity problems resulting from increased surface water runoff due to I/I reduction improvements are less likely, given the relatively low volume reductions that result from I/I rehabilitation.

It is not possible to predict specific locations where problems will occur; therefore drainage complaints should be monitored after the I/I removal improvements are performed to better identify any potential negative drainage impacts.

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Skyway_ProjectArea_DrainageComplaints.mxd - peter keum
Data Source: King County

Figure 4 - 1

Drainage Complaints Identified by IMAP in Skyway Project Area

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

CHAPTER 5.
FIELD RECONNAISSANCE AND PARCEL DIFFICULTY RATINGS

The I/I reduction approach developed in King County's 2004 benefit/cost report was used as a starting point for this alternatives analysis. However, a key assumption of that approach—that unit costs for I/I rehabilitation work could be applied uniformly across all properties in all mini-basins—was brought into question early in this effort. Field visits to the project areas suggested that the range of natural and developed conditions within each mini-basin would result in a range of costs for performing rehabilitation work. In order to account for this variation, a detailed field reconnaissance was performed, and "difficulty ratings" were established for every parcel in the four project areas. The field reconnaissance and difficulty ratings are described in the following sections.

5.1 FIELD RECONNAISSANCE

Initial field reconnaissance consisting of windshield and walking surveys was performed in portions of each project area. Access to private property was not feasible, so field observations were limited to those that could be made from the right of way or from easements traversing open space. The purpose of the initial field reconnaissance was to assess the general topographic and physical characteristics of the parcels in each mini-basin, in order to allow for quick assessment of individual parcels. These assessments could be used to assign appropriate unit costs for the rehabilitation of each parcel.

Following the initial field reconnaissance, a full field review of all the parcels in each project area was performed to assess key parameters. The following parameters were assessed during the full field review:

- Topography of the parcel—Topography of the parcels ranged form relatively flat to slopes over 40 percent, and often varied dramatically between adjacent parcels.
- Access to the sewer main serving the parcel—The location of the main serving the parcel was typically consistent among parcels on the same street, but this was not always the case. Main location was either in front of the parcel or behind the parcel, but the access to the main was observed to be either from a paved street right of way, across an unimproved easement within a greenbelt or forest, or from an easement running through developed parcels. In many cases, where a main was located in a greenbelt or forest, it was evident that the main would have to be accessed through the parcel it served, as access along the easement would require forest clearing and grading of an access route.
- Access to the side sewer point of connection to the building waste line—Access to the side sewer point of connection was related in large part to the topography. In cases where the building served has a level below-grade, access to the side sewer point of connection would require deep excavation. In locations were the topography was steep, accessing the point of connection with construction equipment would be more difficult. In many cases, the building had only one floor, and access could be gained across a level driveway or lawn area.
- Level of improvement of the parcel—Assessment of the level of improvement took into consideration the presence of walls, structures, decorative pavements, and the degree of landscaping on the parcel. The level of improvement appeared to be largely related to topography. In most cases where a parcel was in an area of greater relief, parcels were developed with rockeries, retaining walls and larger shrubs and landscaping occupying the majority of the site. In areas of more moderate or flatter relief, parcels tended to have pockets

of large landscape plantings and decorative pavements, but large areas of the parcels were low groundcovers and lawns.

5.2 PARCEL DIFFICULTY RATING

The field review of individual parcels in the project areas led to the development of three levels of difficulty for performing rehabilitation on each parcel: easy, medium, and difficult. Table 5-1 lists the characteristics of each parameter for the individual levels of difficulty. These ratings are used to associate a level of difficulty and cost with each parcel where it is feasible to perform rehabilitation of laterals and side sewers for I/I reduction.

TABLE 5-1.
CRITERIA FOR ESTABLISHING LEVEL OF DIFFICULTY BY PARCEL

	Easy	Medium	Difficult
Layout	Individual side sewer and lateral	Shared side sewer or individual side sewer and lateral	Shared side sewer or individual side sewer and lateral
Topography	Low to moderate relief	High relief	High relief
Main Access	Main located in improved right of way	Main located in improved right of way	Main located in easement within developed property or within forested greenbelt with difficult access
Point of Connection Access	Ground floor or basement access	Access at basement level	Access in rear yard
Level of Improvement	Low to moderate level of improvement	Moderate to high level of improvement	Moderate to high level of improvement

The pipe summary spreadsheet created to summarize SSES data includes the distribution of the three difficulty levels for each mini-basin. For each main line run, a number has been entered representing the number of parcels served by that main that have been rated easy, medium and difficult. Table 5-2 summarizes the difficulty ratings for each mini-basin.

TABLE 5-2.
DIFFICULTY RATINGS BY MINI-BASIN

Mini-Basin	Total Number of Parcels	Easy Parcels		Medium Parcels		Difficult Parcels	
		Number	% of Total	Number	% of Total	Number	% of Total
BEL011	259	92	36	105	41	62	24
BEL012	441	84	19	202	46	155	35
BEL031	213	97	46	28	13	88	41
BEL032	223	85	38	20	9	118	53
Eastgate Total	**1,136**	**358**	**32**	**355**	**31**	**423**	**37**
ISS003[a]	133	39	29	80	60	12	9
ISS004[a]	293	91	31	76	26	27	9
Issaquah Total[a]	**426**	**130**	**30**	**156**	**37**	**39**	**9**
BLS001	391	176	45	138	35	77	20
BLS002	386	308	80	56	15	22	6
BLS003	232	131	56	60	26	41	18
Skyway Total	**1,009**	**615**	**61**	**253**	**25**	**141**	**14**

a. Percentages do not add to 100% for the Issaquah mini-basins because each of these basins included multi-family parcels where rehabilitation is not practical and single-family parcels where the difficulty was sufficient to make rehabilitation infeasible; difficulty ratings were not assigned for these parcels. Mini-Basin ISS003 has two such parcels and Mini-Basin ISS004 has 99.

CHAPTER 6.
PROJECT SCENARIOS AND ALTERNATIVES

Selection of recommended alternatives for the initial I/I reduction projects started with an evaluation of multiple rehabilitation scenarios for each mini-basin. Based on that initial evaluation, alternatives were developed consisting of selected scenarios for one or multiple mini-basins. The alternatives were evaluated for estimated cost, potential I/I reduction, and cost savings associated with potential elimination or reduction of downstream CSI projects.

6.1 ASSUMPTIONS

6.1.1 Rehabilitation Approach

Conclusions reached based on the SSES and 2003 pilot project findings established the following assumptions about the rehabilitation approach to be used in developing and evaluating initial I/I reduction alternatives:

- The alternatives focus on rehabilitation of side sewers and laterals rather than sewer mains, as these have been found to be the greater source of I/I.
- Cost estimates for the alternatives assume that pipe bursting will be used as the rehabilitation technique (predesign and final design may reveal additional information that would improve the feasibility of pipe lining for portions of the subject systems, and if so, that technique may be used to address the rehabilitation needs in those portions).
- I/I is assumed to be uniformly distributed across 90 percent of each mini-basin, with the exception of specific identified inflow sources. The 90-percent assumption accounts for the few parcels in each mini-basin where side sewers and laterals have recently been replaced and do not exhibit structural defects; these newer side sewers and laterals would not have the same level of I/I as older sections of pipe. Total mini-basin I/I, minus the contribution of inflow sources, was divided by 90 percent of the number of parcels in the mini-basin served by the sewer system to establish a per parcel reduction potential.
- The effectiveness of I/I reduction is assumed to range between 60 and 75 percent. For each alternative, total I/I reduction and associated CSI project cost savings were calculated for the high (75 percent) and low (60 percent) limits of this range.

6.1.2 Cost Assumptions

Unit construction costs per parcel for rehabilitation using pipe bursting were estimated for each of the three level-of-difficulty categories developed from the field reconnaissance. Unit construction costs for the Skyway project area were developed separately from those for Eastgate and Issaquah, in order to account for factors that are not uniform across the project areas, such as jurisdiction-specific overlay requirements and physical site conditions. Site restoration unit prices, for example, are higher for the Eastgate project area than for the Skyway project area, as a result of the typically higher level of landscape development and terrain challenges in the Eastgate area. Table 6-1 summarizes the unit construction costs developed based on project area and parcel level of difficulty.

TABLE 6-1.
UNIT CONSTRUCTION COST FOR I/I REHABILITATION

	Estimated Rehabilitation Cost per Parcel		
	Easy Parcels	Medium Parcels	Difficult Parcels
Eastgate and Issaquah Project Areas			
Side Sewer Pipe Bursting	$8,052	$9,047	$16,445
Lateral and Side Sewer Pipe Bursting	$9,995	$11,995	$16,995
Skyway Project Area			
Side Sewer Pipe Bursting	$3,310	$5,380	$6,600
Lateral and Side Sewer Pipe Bursting	$7,295	$8,515	$11,220

The unit construction costs estimated for this analysis are higher than those assumed in the previous benefit/cost analysis ($3,500 for all side sewer rehabilitations and $6,800 for all lateral and side sewer rehabilitations). This is because the field reconnaissance found that conditions in some of the project areas are considerably more difficult than previously assumed. Construction cost numbers derived from the pilot projects generally were not representative of conditions observed in the field reconnaissance. Construction cost escalation in the years since the pilot projects also had to be accounted for.

For all parcels and project areas, a unit construction cost of $3,000 was assumed for direct disconnects to remove inflow sources identified by the smoke testing.

Total project costs were estimated from construction costs assuming 9 percent for sales tax, 53 percent for allied costs, and 30 percent for contingency.

6.2 MINI-BASIN REHABILITATION SCENARIOS

6.2.1 Development of Scenarios

The mini-basin rehabilitation scenarios consist of varying combinations of improvements to manholes, side sewers and laterals and direct disconnections of roof drains and yard drains from the sewer system. The following are typical mini-basin rehabilitation scenarios:

- Rehabilitate laterals and side sewers on 50 percent of service parcels; rehabilitate only side sewers on 45 percent of service parcels; and implement direct disconnects on 4 percent of service parcels (this scenario, which does not distinguish between easy, medium and difficult parcels, was defined as "Technique 4" in the 2005 *Benefit/Cost Analysis Report* and was the recommended scenario in that report).
- Rehabilitate laterals and side sewers on 95 percent of service parcels.
- Rehabilitate laterals and side sewers on all easy and medium service parcels.
- Rehabilitate laterals and side sewers on 95 percent of easy and medium service parcels.

Variations of these scenarios were developed as appropriate for each mini-basin. The goal was to establish and evaluate a reasonable range of I/I reduction approaches in order to find a suitable balance between construction cost and I/I reduction. Where smoke testing identified direct inflow sources, direct disconnects to eliminate the inflow sources are included in the rehabilitation scenarios. In all, 46 rehabilitation scenarios were developed and evaluated for nine mini-basins.

6.2.2 Evaluation of Scenarios

Figure 6-1 shows a description of how each scenario was evaluated, using one scenario from the Eastgate project area (BEL031-E) as an example; detailed spreadsheets for this scenario are included in Appendix C.

- I/I removal was estimated as follows:
  - Determine remaining I/I after direct disconnects as the estimated mini-basin I/I minus the estimated inflow from direct connections. For Mini-Basin BEL031, the estimated I/I is 1.31 mgd and the estimated inflow through direct connections is 0.063 mgd:
    Remaining I/I = 1.25 mgd.
  - Calculate I/I allocation per parcel by dividing the remaining I/I by 90 percent of the number of parcels in the mini-basin. In Mini-Basin BEL031, there are 213 parcels, so the unit I/I per parcel is 1.25 mgd divided by 192 (90 percent of 213):
    I/I per parcel = 0.0065 mgd, or 4.52 gallons per minute (gpm).
  - Determine the number of parcels rehabilitated, based on the scenario. Scenario BEL031-E is defined as rehabilitation of 95 percent of parcels rated easy (97) or medium (28), less 10 percent to account for PVC connections not needing rehabilitation:
    Rehabilitated parcels = 107 (82 easy, 25 medium).
  - Calculate I/I to be removed through rehabilitation as the unit I/I per parcel times the number of rehabilitated parcels times the assumed rehabilitation effectiveness (60 percent or 75 percent). For Scenario BEL031-E, this is 4.52 gpm per parcel times 107 parcels time the percent effectiveness:
    Rehabilitation I/I removal (60% effectiveness) = 290 gpm, or 0.42 mgd
    Rehabilitation I/I removal (75% effectiveness) = 363 gpm, or 0.52 mgd
  - Calculate total I/I removal as the sum of removal from direct disconnects and removal from rehabilitation. For Scenario BEL031-E, direct disconnects would remove 0.063 mgd and rehabilitation would remove 0.42 mgd (60 percent effectiveness) or 0.52 mgd (75 percent effectiveness):
    Total I/I removal (60% effectiveness) = 0.48 mgd
    Total I/I removal (75% effectiveness) = 0.58 mgd
- Project cost for each scenario was estimated as follows:
  - Construction cost for rehabilitation was calculated based on the work included in the scenario and the unit costs presented in Table 6-1. Scenario BEL031-E includes side sewer and lateral rehabilitation on 82 easy parcels at $9,995 each and 25 medium parcels at $11,995 each:
    Rehabilitation construction cost = $1,119,000
  - Total construction cost is the sum of rehabilitation construction cost and construction cost for direct disconnects. Scenario BEL031-E includes two direct disconnects at $3,000 each:
    Direct disconnect construction cost = $6,000
    Total construction cost (rehabilitation + direct disconnects) = $1,125,000
  - Project cost is the construction cost plus sales tax, allied cost and contingency. For Scenario BEL031-E these values are as follows:
    Sales tax (9% of construction cost) = $101,000
    Allied costs (53% of the sum of construction cost and sales tax) = $650,000
    Contingency (30% of the sum of construction cost, sales tax and allied cost) = $563,000
    Total project cost = $2,440,000 (rounded)

Figure 6-1. Example Evaluation of I/I Scenario, Using Eastgate Scenario BEL031-E

In evaluating the rehabilitation scenarios, it became evident that the per-parcel distribution of I/I can be used to quickly determine whether a scenario has the potential to be cost-effective. It was found that in areas where there is less than 3 gpm of I/I per parcel, it typically will not be cost-effective to remove it through rehabilitation. In these cases it requires rehabilitation of too many individual properties, making implementation of the downstream conveyance improvement needs more cost-effective. Based on the evaluation, 20 scenarios in seven mini-basis were selected to create initial I/I reduction alternatives. Table 6-2 summarizes the scenarios developed and carried forward, by mini-basin.

TABLE 6-2.
MINI-BASIN REHABILITATION SCENARIOS

Mini-Basin	Number of Scenarios Evaluated	Scenarios Carried Forward for Use in Alternatives
BEL011	4	BEL011-D, BEL011-E
BEL012	4	BEL012-D, BEL012-E
BEL014	None (removed from evaluation based on SSES)	None
BEL031	5	BEL031-D, BEL031-E
BEL032	5	BEL032-D, BEL032-E
ISS003	8	ISS003C(2), ISS003D(2), ISS003E(2)
ISS004	6	None
RNT005	None (removed from evaluation based on SSES)	None
BLS001	2	None
BLS002	7	BLS002B, BLS002B1, BLS002B2, BLS002C, BLS002E, BLS002F
BLS003	5	BLS003B, BLS003C, BLS003E

6.3 I/I REDUCTION ALTERNATIVES

Mini-basin rehabilitation scenarios selected for use in alternatives were evaluated individually or in combinations, based on the downstream CSI project that could be affected by their implementation. Twenty-seven alternatives were developed from the selected scenarios:

- 16 alternatives were created from one or two Eastgate mini-basins.
- 3 alternatives were created from individual Issaquah mini-basins.
- 1 alternative was created from one Eastgate mini-basin and one Issaquah mini-basin.
- 7 alternatives were created from one or two Skyway mini-basins.

Table 6-3 summarizes the alternatives, along with their estimated total I/I removal and project cost, determined as described for the evaluation of scenarios.

The alternatives and their estimated impacts on I/I were provided to King County's modeling group to assess the potential for reducing or eliminating downstream CSI projects due to the reduced I/I flows. Cost savings associated with CSI project reduction allowed by each initial I/I reduction alternative were

estimated for comparison to the construction costs for the alternative. Alternatives with a benefit/cost ratio of 1.0 or greater may be recommended for implementation as initial I/I reduction projects. Table 6-4 summarizes the results of the benefit/cost analysis.

TABLE 6-3.
INITIAL I/I REDUCTION ALTERNATIVES SUMMARY

Alternative	Rehabilitation Scenarios Included	Properties Rehabilitated	Total I/I Project Cost ($million)	Total I/I Removal (mgd) 60% Effective	Total I/I Removal (mgd) 75% Effective
BEL-F	BEL031-D BEL032-E	82 easy, 25 medium, 75 difficult 69 easy, 17 medium, 0 difficult	$7.15	0.97	1.19
BEL-G	BEL031-E BEL032-D	82 easy, 25 medium, 0 difficult 69 easy, 17 medium, 105 difficult	$8.25	0.90	1.10
BEL-H	BEL031-D BEL032-D	82 easy, 25 medium, 75 difficult 69 easy, 17 medium, 105 difficult	$11.02	1.19	1.47
BEL-I	BEL031-E BEL032-E	82 easy, 25 medium, 0 difficult 69 easy, 17 medium, 0 difficult	$4.38	0.68	0.82
BEL-J	BEL031-D	82 easy, 25 medium, 75 difficult	$5.20	0.77	0.95
BEL-K	BEL031-E	82 easy, 25 medium, 0 difficult	$2.44	0.48	0.58
BEL-L	BEL032-D	69 easy, 17 medium, 105 difficult	$5.81	0.42	0.52
BEL-M	BEL032-E	69 easy, 17 medium, 0 difficult	$1.94	0.20	0.24
BEL-R	BEL011-D BEL012-E	78 easy, 89 medium, 53 difficult 71 easy, 172 medium, 0 difficult	$12.07	0.97	1.21
BEL-S	BEL011-E BEL012-D	78 easy, 89 medium, 0 difficult 71 easy, 172 medium, 132 difficult	$14.98	1.14	1.41
BEL-T	BEL011-D BEL012-D	78 easy, 89 medium, 53 difficult 71 easy, 172 medium, 132 difficult	$16.93	1.24	1.54
BEL-U	BEL011-E BEL012-E	78 easy, 89 medium, 0 difficult 71 easy, 172 medium, 0 difficult	$10.11	0.87	1.08
BEL-V	BEL011-D	78 easy, 89 medium, 53 difficult	$5.99	0.46	0.57
BEL-W	BEL011-E	78 easy, 89 medium, 0 difficult	$4.04	0.36	0.44
BEL-X	BEL012-D	71 easy, 172 medium, 132 difficult	$10.94	0.78	0.97
BEL-Y	BEL012-E	71 easy, 172 medium, 0 difficult	$6.08	0.51	0.64
ISS-E	ISS003C(2)	31 easy, 76 medium, 11 difficult	$3.19	0.40	0.51
ISS-F	ISS 003D(2)	37 easy, 76 medium, 0 difficult	$2.79	0.37	0.46
ISS-G	ISS003E(2)	37 easy, 0 medium, 0 difficult	$0.81	0.12	0.15
BEL/ISS-B[a]	BEL031-E ISS003D(2)	82 easy, 25 medium, 0 difficult 37 easy, 76 medium, 0 difficult	$5.23	0.85	1.04
BLS-B	BLS002B	190 easy, 0 medium, 0 difficult	$3.07	1.15	1.38
BLS-B1	BLS002B1	210 easy, 0 medium, 0 difficult	$3.39	1.25	1.50
BLS-B2	BLS002B2	185 easy, 0 medium, 0 difficult	$2.99	1.26	1.51
BLS-B3	BLS003B	124 easy, 56 medium, 28 difficult	$3.73	1.03	1.27
BLS002 /003-C	BLS002C BLS003C	120 easy, 0 medium, 0 difficult 69 easy, 50 medium, 13 difficult	$3.09	1.18	1.40
BLS-F[a]	BLS002F	292 easy, 51 medium, 0 difficult	$5.63	1.82	2.25
BLS-E[a]	BLS002E BLS003E	270 easy, 0 medium, 0 difficult 50 easy, 13 medium, 2 difficult	$5.47	1.82	2.24

a. Indicates alternatives selected for further evaluation, as described in Chapter 7.

TABLE 6-4.
BENEFIT/COST ANALYSIS FOR INITIAL I/I REDUCTION ALTERNATIVES

Alternative	CSI Projects Affected	CSI Project Size Reduction (MG)		Total CSI Project Cost Savings ($ million)		Benefit/Cost Ratio	
		60% Effective	75% Effective	60% Effective	75% Effective	60% Effective	75% Effective
BEL-F	• Eastgate Storage • Issaquah Storage	0.30 0.43	0.37 0.52	$6.00	$7.33	0.84	1.03
BEL-G	• Eastgate Storage • Issaquah Storage	0.28 0.40	0.34 0.49	$5.60	$6.79	0.68	0.82
BEL-H	• Eastgate Storage • Issaquah Storage	0.37 0.52	0.46 0.64	$7.33	$9.01	0.67	0.82
BEL-I	• Eastgate Storage • Issaquah Storage	0.21 0.31	0.26 0.37	$4.27	$5.12	0.97	1.17
BEL-J	• Eastgate Storage • Issaquah Storage	0.24 0.35	0.30 0.42	$4.82	$5.89	0.93	1.13
BEL-K	• Eastgate Storage • Issaquah Storage	0.15 0.22	0.18 0.26	$3.03	$3.66	1.24	1.50
BEL-L	• Eastgate Storage • Issaquah Storage	0.13 0.19	0.16 0.24	$2.65	$3.29	0.46	0.57
BEL-M	• Eastgate Storage • Issaquah Storage	0.06 0.09	0.07 0.11	$1.27	$1.52	0.65	0.78
BEL-R	• Eastgate Storage • Issaquah Storage	0.30 0.43	0.38 0.53	$6.00	$7.44	0.50	0.62
BEL-S	• Eastgate Storage • Issaquah Storage	0.35 0.50	0.44 0.62	$7.03	$8.65	0.47	0.58
BEL-T	• Eastgate Storage • Issaquah Storage	0.39 0.54	0.48 0.67	$7.63	$9.43	0.45	0.56
BEL-U	• Eastgate Storage • Issaquah Storage	0.27 0.39	0.34 0.48	$5.40	$6.68	0.53	0.66
BEL-V	• Eastgate Storage • Issaquah Storage	0.14 0.21	0.18 0.26	$2.92	$3.59	0.49	0.60
BEL-W	• Eastgate Storage • Issaquah Storage	0.11 0.17	0.14 0.20	$2.30	$2.79	0.57	0.69
BEL-X	• Eastgate Storage • Issaquah Storage	0.24 0.35	0.30 0.43	$4.89	$6.00	0.45	0.55
BEL-Y	• Eastgate Storage • Issaquah Storage	0.16 0.23	0.20 0.29	$3.22	$4.04	0.53	0.66
ISS-E	• Eastgate Storage • Issaquah Storage • Issaquah Interceptor	0.12 0.18 0.00	0.15 0.22 0.65	$2.42	$3.11	0.76	0.97
ISS-F	• Eastgate Storage • Issaquah Storage • Issaquah Interceptor	0.11 0.16 0.00	0.13 0.20 0.59	$2.18	$2.83	0.78	1.02

TABLE 6-4 (continued).
BENEFIT/COST ANALYSIS FOR INITIAL I/I REDUCTION ALTERNATIVES

Alternative	CSI Projects Affected	CSI Project Size Reduction (MG)		Total CSI Project Cost Savings ($ million)		Benefit/Cost Ratio	
		60% Effective	75% Effective	60% Effective	75% Effective	60% Effective	75% Effective
ISS-G	• Eastgate Storage • Issaquah Storage	0.03 0.05	0.04 0.06	$0.71	$0.90	0.88	1.11
BEL/ISS-B[a]	• Eastgate Storage • Issaquah Storage • Issaquah Interceptor	0.26 0.37 0.00	0.32 0.45 0.59	$5.12	$6.37	0.98	1.22
BLS-B	• Bryn Mawr Storage	0.05	0.06	$0.51	$0.63	0.17	0.21
BLS-B1	• Bryn Mawr Storage	0.05	0.06	$0.56	$0.71	0.17	0.21
BLS-B2	• Bryn Mawr Storage	0.05	0.06	$0.56	$0.71	0.19	0.24
BLS-B3	• Bryn Mawr Storage	0.05	0.06	$0.51	$0.63	0.14	0.17
BLS002 /003-C	• Bryn Mawr Storage	0.05	0.06	$0.52	$0.63	0.17	0.20
BLS-F[a]	• Bryn Mawr Storage	0.27	0.27	$5.37	$5.37	1.00[b]	1.00[b]
BLS-E[a]	• Bryn Mawr Storage	0.27	0.27	$5.37	$5.37	1.00[c]	1.00[c]

a. Indicates alternatives selected for further evaluation, as described in Chapter 7.
b. Benefit/cost ratio includes $260,000 cost-sharing with Skyway Water and Sewer District.
c. Benefit/cost ratio includes $100,000 cost-sharing with Skyway Water and Sewer District.

CHAPTER 7.
RECOMMENDED PROJECTS AND IMPLEMENTATION

7.1 RECOMMENDATIONS

Analysis indicates that cost-effective rehabilitation is feasible in only four mini-basins: Mini-Basin BEL031 in Eastgate; Mini-Basin ISS003 in Issaquah; and Mini-Basins BLS002 and BLS003 in Skyway. Figures 7-1 through 7-4 show the level-of-difficulty maps for these four mini-basins. Cost-effective rehabilitation in all other mini-basins is limited due to a low I/I allocation per property (requiring a greater number of properties to be rehabilitated) and high unit costs for rehabilitation because of difficult field conditions.

7.1.1 Comparison of Selected Alternatives

Three alternatives addressing the four selected mini-basins meet the cost-effectiveness requirements of providing a benefit/cost ratio of 1.0 or greater: The combined Eastgate/Issaquah Alternative BEL/ISS-B, in Mini-Basins BEL031 and ISS003; Skyway Alternative BLS-F, in Mini-Basin BLS002; and Skyway Alternative BLS-E, in Mini-Basins BLS002 and BLS003. (Eastgate Alternative BEL-K, which also meets the cost-effectiveness requirement, is included in Alternative BEL/ISS-B and is so not evaluated separately.) Detailed project spreadsheets for each alternative are included in Appendix C. A detailed comparison of these alternatives was performed to identify recommended alternatives. The comparison is summarized in Table 7-1.

- CSI project cost savings—The CSI project cost savings for 60-percent and 75-percent I/I removal effectiveness are as described in Chapter 6 and shown in Table 6-4. For Skyway Alternatives BLS-F and BLS-E, the CSI project cost savings are the same for 60-percent and 75-percent I/I removal effectiveness, because 60-percent removal would eliminate the need for the Bryn Mawr Storage CSI project downstream. No additional savings are realized for 75-percent removal.

7.1.2 Recommended Alternatives

Alternative BEL/ISS-B is recommended for the Eastgate and Issaquah project areas. Although this project is marginally below the cost-effectiveness threshold of 1.0 if only 60-percent I/I removal is achieved, past similar projects have shown I/I removal rates on average of 77 percent. The cost estimate for I/I reduction is also conservatively estimated, therefore the risk is minimized that the project would not achieve cost-effectiveness.

For the Skyway project area, Alternative BLS-F is recommended over BLS-E for the following reasons:

- There is a higher degree of confidence in the flow monitoring data for Mini-Basin BLS002 than the data for BLS003. Deriving the amount of I/I in BLS003 required subtraction of upstream meter data, which has a higher likelihood of error being introduced.
- Smoke testing in Mini-Basin BLS002 resulted in the identification of significantly more direct connections and defects than in Mini-Basin BLS003.
- Alternative BLS-F concentrates construction in a single mini-basin—Mini-Basin BLS002. If additional I/I reduction is found to be needed following implementation of the initial projects, then work could be performed in Mini-Basin BLS003 without disrupting any neighborhood twice with construction.

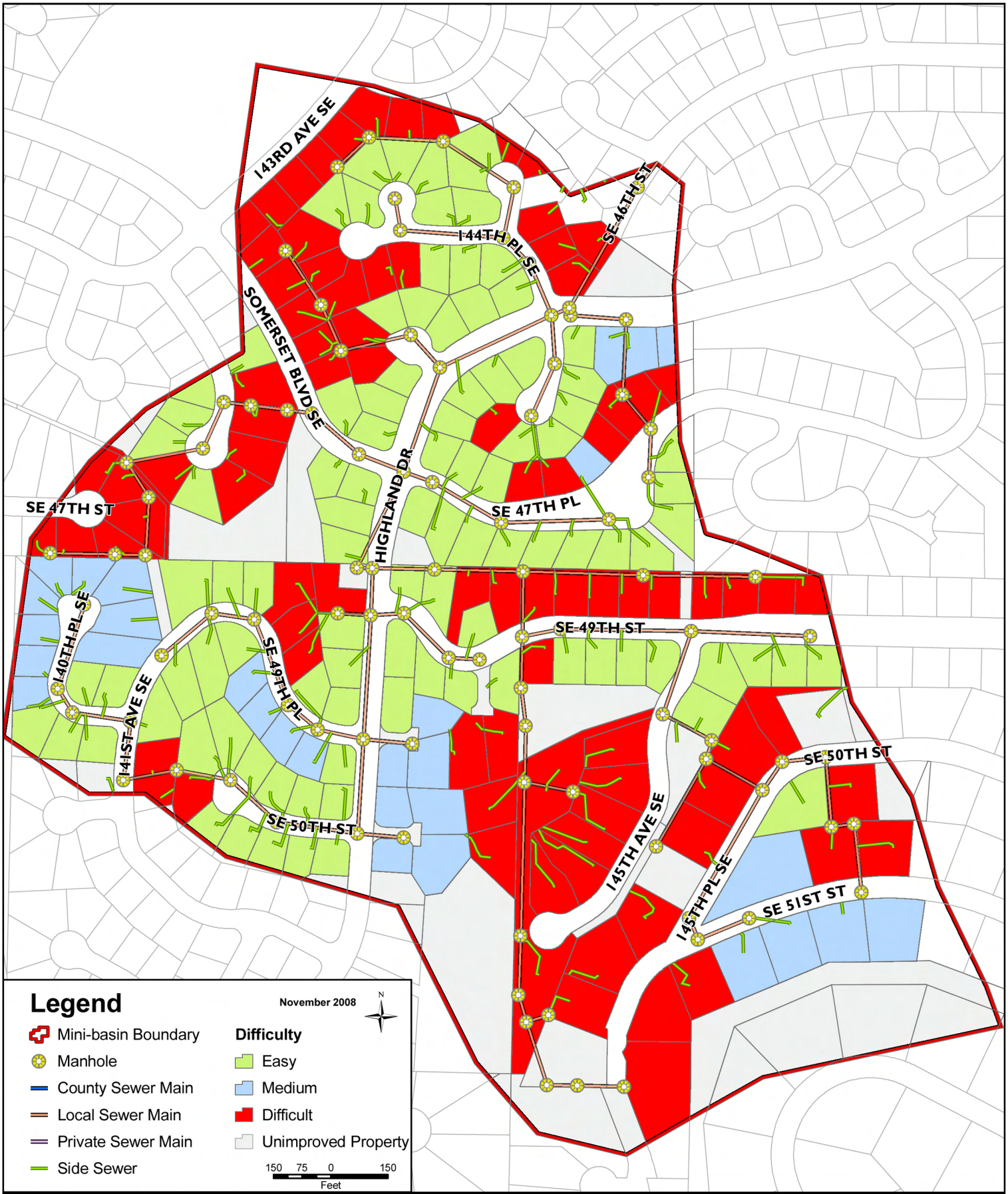
TABLE 7-1.
SUMMARY OF POTENTIAL I/I REDUCTION ALTERNATIVES

	Eastgate/Issaquah BEL/ISS-B	Skyway BLS-F	Skyway BLS-E
Description	Rehabilitate 50% of laterals and side sewers in Mini-Basin BEL031 (82 easy, 25 medium) and 85% in Mini-Basin ISS003 (37 easy, 76 medium).	Rehabilitate 89% of laterals and side sewers in Mini-Basin BLS002 (292 easy, 51 medium).	Rehabilitate 70% of laterals and side sewers in Mini-Basin BLS002 (270 easy) and 28% in Mini-Basin BLS003 (50 easy, 13 medium, 2 difficult).
Preliminary Construction Method	—— Pipe bursting, open cut where necessary ——		
Private Property Entry Agreements Needed	220	343	335
Estimated Construction Year	2012	2011	—
Estimated I/I Reduction	0.85 mgd @ 60%; 1.04 mgd @ 75%	1.82 mgd @ 60%; 2.25 mgd @ 75%	1.82 mgd @ 60%; 2.24 mgd @ 75%
Estimated Construction Cost	$3.41 million	$3.68 million	$3.57 million
Estimated Project Cost	$5.23 million	$5.63 million	$5.47 million
CSI Project Impact, 60% I/I Reduction			
Size Reduction	Eastgate Storage: 0.26 MG Issaquah Storage: 0.37 MG	Bryn Mawr Storage: 0.27 MG	Bryn Mawr Storage: 0.27 MG
Project Cost Savings	$5.12 million[a]	$5.37 million[b]	$5.37 million[c]
CSI Project Impact, 75% I/I Reduction			
Size Reduction	Eastgate Storage: 0.32 MG Issaquah Storage: 0.45 MG Issaquah Interceptor: 0.59 mgd	—	—
Project Cost Savings	$6.37 million	—[d]	—[d]
Life Cycle Cost Savings	Negligible	—	—

a. The Eastgate/Issaquah I/I project is marginally below the cost-effective threshold of 1.0 if only 60% I/I reduction is achieved. However, past similar projects have shown I/I reduction rates on average of 77%. The cost estimate for I/I reduction is also conservatively estimated, therefore the risk is minimized that the project would not achieve cost effectiveness.
b. Net savings for Skyway Alternative BLS-F assumes $260,000 cost sharing from Skyway Water and Sewer District.
c. Net savings for Skyway Alternative BLS-E assumes $100,000 cost sharing from Skyway Water and Sewer District.
d. For Skyway Alternatives BLS-F and BLS-E, the CSI project cost savings are the same for 60 percent and 75-percent I/I removal effectiveness, because 60-percent removal would eliminate the need for the Bryn Mawr Storage CSI project downstream. No additional savings are realized for 75-percent removal.

- The Skyway Water and Sewer District wishes to add additional funding to the project to rehabilitate the district's sewer mains and manholes in the impacted mini-basin areas. Concentrating work within Mini-Basin BLS002 allows the rehabilitation of more mains and manholes, increasing the likelihood of achieving the target I/I reduction.

Figures 7-5 and 7-6 show the recommended project locations.



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

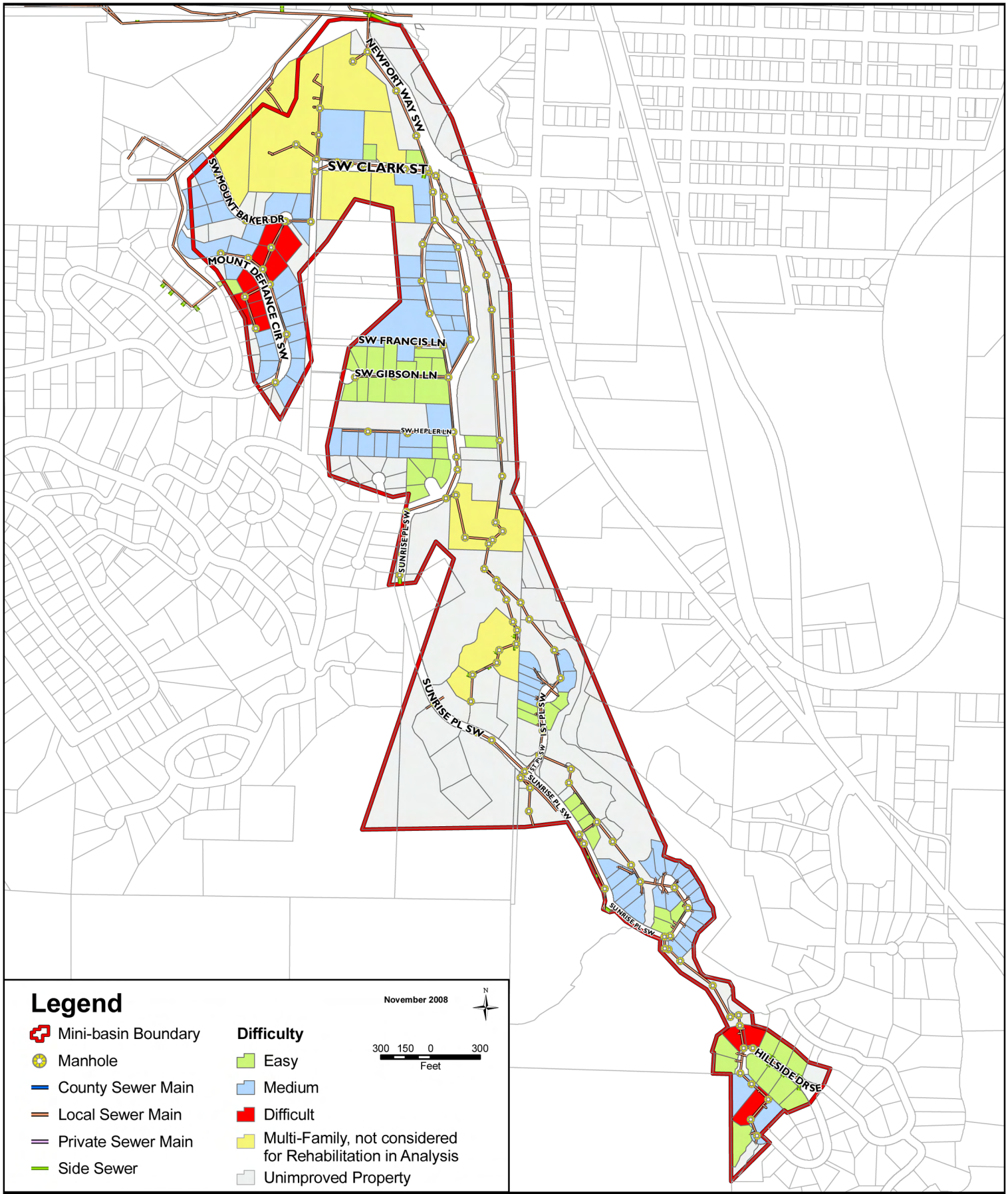
File Name: K:\kingco_ii\Bellevue\BEL31_difficulty_reportfig

Data Source: King County

Figure 7-1

Mini-Basin BEL031
Parcel Difficulty Ratings

Initial Infiltration and Inflow Reduction Alternatives Analysis Report



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: K:\kingco_ii\Issaquah\ISS003_difficulty_reportfig

Data Source: King County

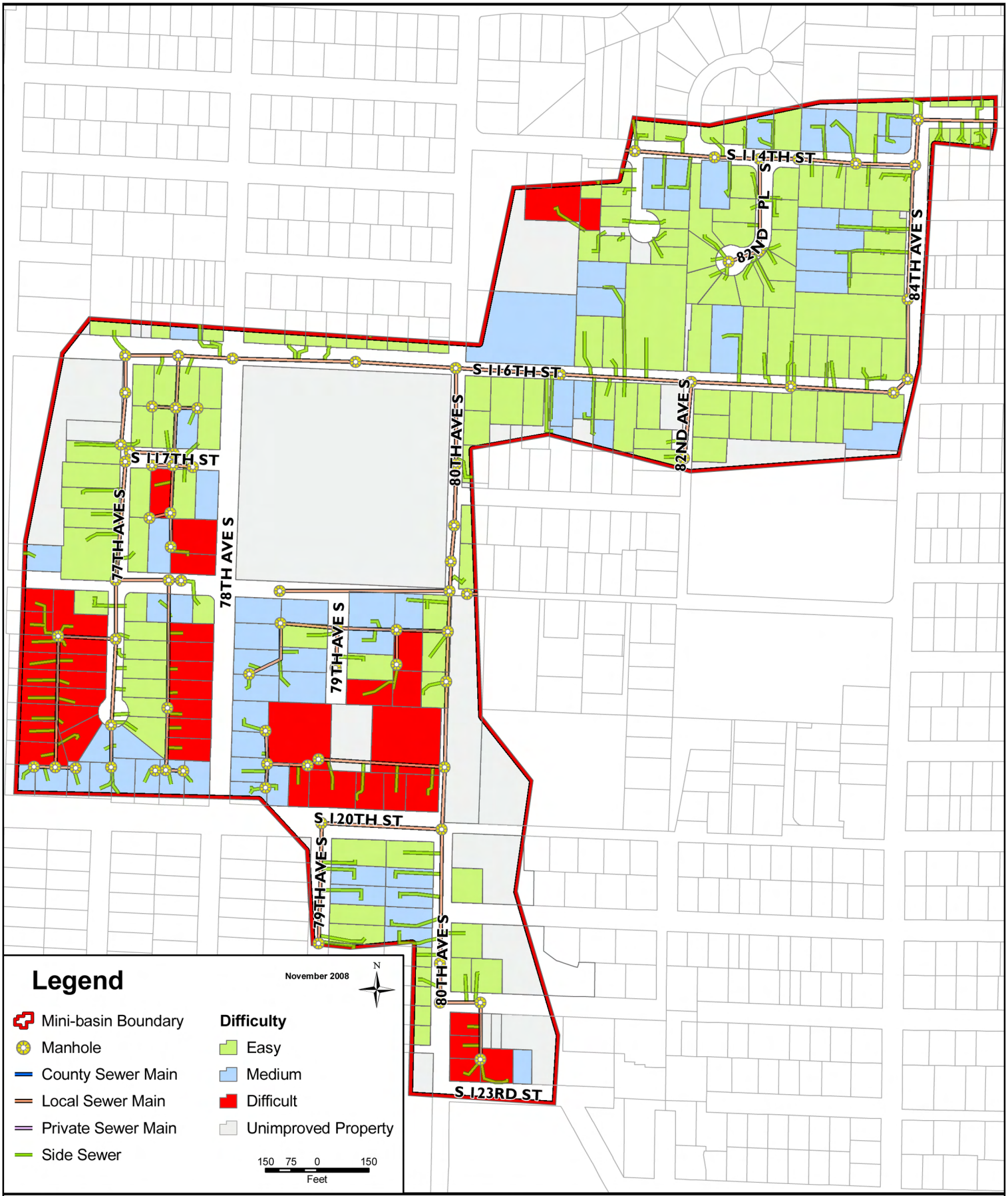
Figure 7-2
Mini-Basin ISS003
Parcel Difficulty Ratings
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: K:\kingco_ii\Skyway\BLS002_difficulty_reportfig

Data Source: King County

Figure 7-3
Mini-Basin BLS002
Parcel Difficulty Ratings
Initial Infiltration and Inflow Reduction Alternatives Analysis Report



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: K:\kingco_ii\Skyway\BLS003_difficulty_reportfig

Data Source: King County

Figure 7-4
Mini-Basin BLS003
Parcel Difficulty Ratings
Initial Infiltration and Inflow Reduction Alternatives Analysis Report

7.2 PERMITTING

Several local permits will be required for the proposed project, as summarized in Table 7-2. Because no earthwork in wetlands or streams is anticipated for the recommended projects, the National Pollutant Discharge Elimination System permit is the only state permit required for the project and no federal permits are required. However, if the projects change and work in wetlands or streams is proposed in any of the basins, one or both of two other state permits would be required, as well as one federal permit from the U.S. Army Corps of Engineers. Table 7-3 summarizes state and federal permits that would be required in any basin where work in wetlands or streams was required. Further discussion of each permit is included in Appendix D.

7.3 RIGHTS OF ENTRY

A right-of-entry agreement (ROE) will be required from the property owner before rehabilitation can occur on an individual property. The simple agreement allows the county and its contractor access to a property to perform rehabilitation. Areas disturbed by construction are required to be restored in kind per the agreement. Although simple, the ROE gathering process can be time-consuming. Multiple contacts with property owners are often required before an ROE is attained.

The recommended projects include rehabilitation of approximately 565 individual properties, making the ROE gathering process a key element of project implementation. Experience on the pilot projects showed that not all property owners are willing to allow access; therefore the ROE process should target 5 to 10 percent more properties than needed for implementation. Property owners who are not agreeable to having work done on their property can then be removed from the project, and replaced with a willing property owner. Attaining sufficient ROEs will likely be most critical in Mini-Basin ISS003, as it is anticipated that the number of key target properties with high I/I levels will be lowest in this mini-basin.

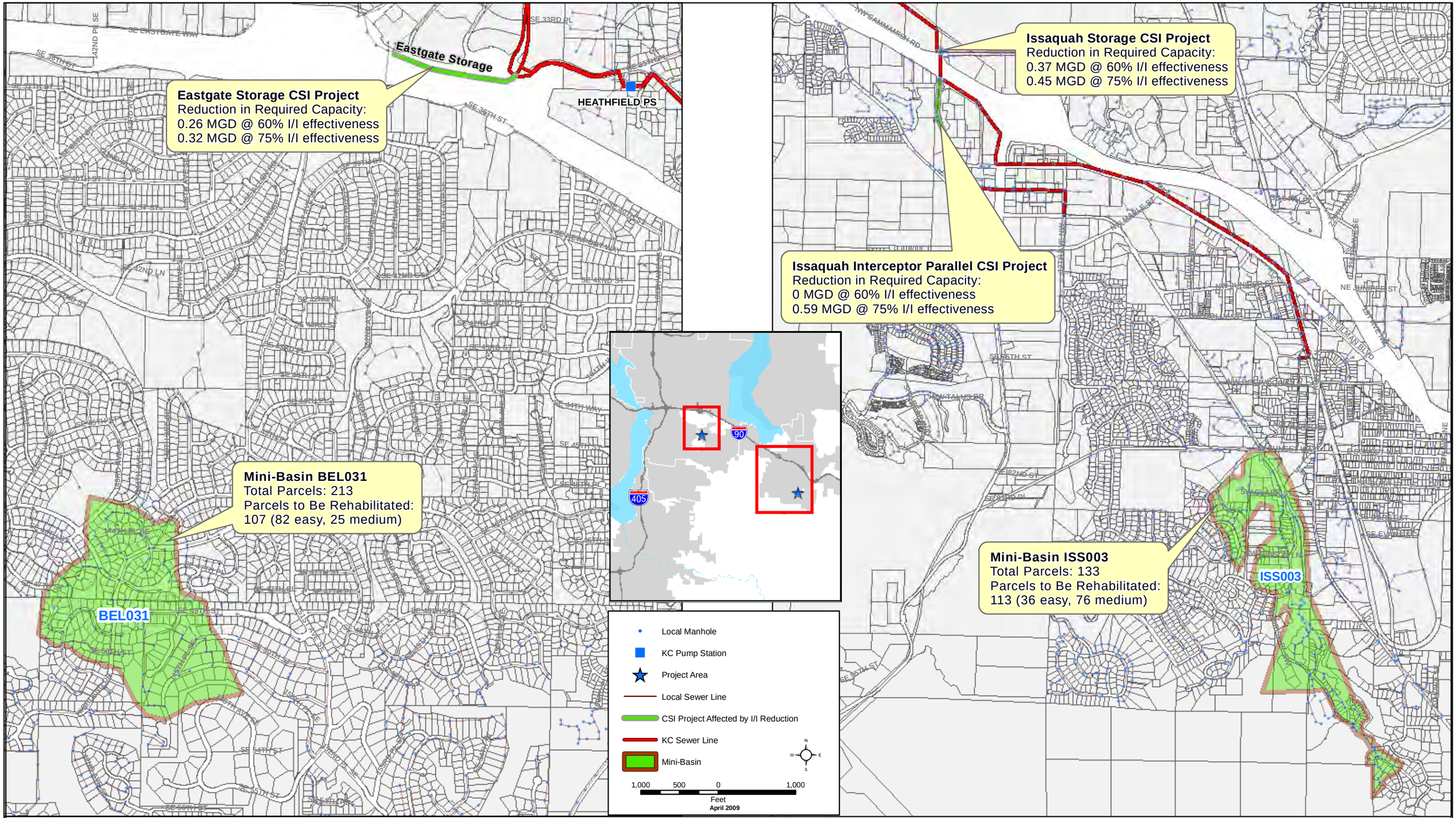
The following are typical issues that often must be addressed to attain ROEs:

- The agreement typically allows work to be accomplished over a time period of one year, but property owners often want a more definitive idea of when their property will be impacted.
- Property owners should be told what type of rehabilitation will be used and what disturbance will occur on the property.
- Residents where English is not the primary language spoken must be identified to assist in communication requirements.
- Property owners may place conditions on the agreement. For instance, a property owner may have specific concerns regarding disturbance of particular surface improvements or landscaping features that need to be addressed in the agreement.

A database tool has been created to facilitate the tracking process for ROEs that will need to be attained. The database will log which properties are targeted for ROEs; where ROEs have been attained; and any special conditions that may be attached to the agreement.

TABLE 7-2.
LOCAL PERMITTING REQUIREMENTS

Permit	Supporting Documents	Permit Application	Issuing Agency	Time to Prepare and Submit Application	Estimated Time of Permit Issuance
Shoreline Management Act Review	Ordinary High Water Mark Delineation	Shoreline Substantial Development Permit application	King County (Mini-Basin BLS002), City of Issaquah (Mini-Basin ISS003),	5 to 6 weeks after 70 percent design is complete	5 months
State Environmental Policy Act/ Critical Areas Review	Wetland Delineation, Wetland and Stream Mitigation, design and grading plans, temporary erosion and sediment control plan, Cultural Resources report (may not be required), and geotechnical report	State Environmental Policy Act Checklist	King County	5 to 6 weeks after 70 percent design is complete	45 days after application is deemed complete
Grading Permit	Grading plan and temporary erosion and sediment control plan	Clearing and Grading Permit Application	King County (Mini-Basin BLS002), City of Issaquah (Mini-Basin ISS003), City of Bellevue (Mini-Basin BEL031)	2 weeks	Reviewed concurrently with State Environmental Policy Act
Street Use Permit	Traffic Control Plan	Street Use Permit Application	King County (Mini-Basin BLS002), City of Issaquah (Mini-Basin ISS003), City of Bellevue (Mini-Basin BEL031)	2 weeks	2 to 3 weeks
Side Sewer Permit	---	Side Sewer Permit Application	Skyway Water and Sewer District (Mini-Basin BLS002), City of Issaquah (Mini-Basin ISS003), City of Bellevue (Mini-Basin BEL031)	2 weeks after rights of entry are obtained	2 to 3 weeks



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Project\ project\TechReport\Reduction_BEL_ISS_B.mxd - peter keum
Data Source: King County & Tetra Tech inc.

Figure 7 - 5

Initial I/I Reduction Project BEL/ISS-B

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: dnrp1:\\wtd\projects\II_Initial_Projec\project \TechReport\Skyway_ProjectArea.mxd - peter keum
Data Source: King County

Figure 7 - 6

Initial I/I Reduction Project BLS - F

Initial Infiltration and Inflow Reduction Alternatives Analysis Report

TABLE 7-3.
POTENTIAL STATE AND FEDERAL PERMITTING REQUIREMENTS

Permit	Supporting Documents	Permit Application	Issuing Agency	Time to Prepare and Submit Application	Estimated Time of Permit Issuance
National Pollution Discharge Elimination System (for construction)	Temporary Erosion and Sediment Control Plan	Storm Water Pollution Prevention Plan	Washington Department of Ecology	typically prepared and submitted by contractor	30 days
Hydraulic Project Approval	Stream Mitigation Plan and State Environmental Policy Act determination	Joint Aquatic Resource Permits Application	Washington Department of Fish & Wildlife	5 to 6 weeks after 70 percent design is complete	45 calendar days after the application is deemed complete and State Environmental Policy Act compliance is complete
Section 404 Permit (Biological Assessment to be included in Joint Aquatic Resource Permits Application submittal)	Wetland Delineation, Wetland and Stream Mitigation, and Biological Assessment	Joint Aquatic Resource Permits Application	U.S. Army Corps of Engineers	5 to 6 weeks after 70 percent design is complete	4 to 12 months, depending on project complexity
Section 401 Permit and Coastal Zone Management Act approval	Wetland Delineation and Wetland and Stream Mitigation	Joint Aquatic Resource Permits Application	Washington Department of Ecology	5 to 6 weeks after 70 percent design is complete	3 months

7.4 AGENCY COORDINATION

The recommended projects must be considered in the context of local agency planning and capital projects. Examples of this include opportunities for incorporating planned overlays or improvements by the local agencies to realize greater economy, or scheduling I/I work to minimize impacts on residents where separate local agency work is planned. King County should also expect to share with each local agency the SSES and mapping work that was performed for this alternatives analysis. The following sections describe specific agency coordination issues for the Initial I/I Reduction projects.

7.4.1 Eastgate

The following coordination issues would apply to work in Eastgate Mini-Basin BEL031:

- Coordinate with City of Bellevue Transportation Department to implement roadway overlays required for the streets in the mini basin. Overlay of the streets is required following any project that includes street trenching.
- Coordinate with City of Bellevue Utilities Department regarding potential storm drainage improvements in the area to avoid conflicts and possibly schedule work prior to overlays.

- A small segment of the southeast corner of the mini-basin is in unincorporated King County. King County Roads has near-term plans to overlay a short segment of roadway in the mini-basin along SE 51st Street. Coordinate with the County to postpone potential pavement overlay work planned for the area until the end of the sewer project.
- Coordinate with City of Bellevue Utilities Department for planned replacements of portions of AC water main in the mini-basin. The Department does not plan for this replacement work to take place in the short term. However, as the I/I project would trigger overlaying of the roadways, the Department would move the replacement project up in its schedule to accomplish the work prior to any overlay work.
- Coordinate with Bellevue Utilities Department regarding communication with district customers about direct disconnects. While the Department has no formal policy regarding this at this time, the Department understands and supports the need for disconnects and intends to help facilitate this process.
- Share SSES data and mapping with the City.

7.4.2 Issaquah

The City of Issaquah has indicated that there are no plans for pavement overlays or utility work within Mini-Basin ISS003 that would require coordination with this project. The City has expressed an interest in the following coordination issues:

- A city council briefing to explain the findings and recommendations of the alternatives analysis.
- Sharing SSES data and mapping with the City.
- A discussion of appropriate rehabilitation techniques to be used.

7.4.3 Skyway

King County Roads has near-term plans to overlay two short segments of roadway in Skyway Mini-Basin BLS002; one segment along Cornell Avenue South and a segment along Laurel Lane South. The following coordination issues would apply to work in this mini-basin:

- Coordinate with King County Roads regarding potential storm drainage improvements in the area to avoid conflicts and possibly schedule work prior to any overlays associated with the storm drainage improvements.
- Coordinate with King County Roads to postpone potential pavement overlay work planned for the area until the end of the sewer project.
- Coordinate with Skyway Water and Sewer District regarding:
  - Communication with district customers with respect to direct disconnects; the District intends to enforce disconnections.
  - Cost sharing for proposed District additions to work (sewer mains and manholes).
  - Sharing SSES data and mapping with the District.

7.5 COMMUNITY RELATIONS

Because the Initial I/I Reduction projects will involve extensive work on private property, a detailed community relations plan will be prepared for each affected mini-basin in consultation with the respective local agencies. The community relations plans will take the following considerations into account:

- The goal of community relations is to support the successful design and implementation of the Initial I/I Reduction projects by providing project information to the public and identifying and responding to community concerns and input.
- A high level of community relations work will be required during the design and construction phases of projects because of the complexity of the projects and their impact on hundreds of private properties.
- The projects will occur primarily in residential areas, although some businesses and public institutions may be included.
- Foreign languages may be the primary languages spoken in some households. This will be an important consideration in developing public information materials and planning public events as well as potentially making door-to-door visits.
- Objectives of the community relations work include:
  - Explain the respective roles and responsibilities of King County and the local agencies.
  - Explain the purpose of the projects.
  - Explain the source of funding for the projects.
  - Explain the benefits of side sewer replacement to property owners.
  - Explain the criteria that King County will use to select properties and why some properties will receive free side sewer replacement while others will not.
  - Partner with the local agencies to develop informational materials, plan public meetings, and coordinate communication with affected property owners.
- Community relations activities will include developing and distributing public information materials, holding public meetings, maintaining a project website, and responding to public inquiries.
- To support the collection of rights of entry, it will be necessary to maintain good records of communication with the public and to establish clear communication protocols for the project team.
- It may be possible to draw from the experiences of property owners who received side sewer rehabilitation during King County's I/I pilot projects.

Each mini-basin is briefly described below with references to potential community relations issues, challenges, and opportunities.

7.5.1 Eastgate Mini-Basin BEL031

Owners of residential properties are the key target audience for this project in Mini-Basin BEL031. Neighborhood, community and homeowner associations are prevalent in the Eastgate area of Bellevue, and those that represent property owners in BEL031 will be targeted for outreach. Preliminary research indicates the following:

- The entire basin is within Bellevue city limits.
- The majority of properties are single-family residences.
- This basin may include higher end properties with landscaping that will be costly to replace.
- English is the primary language spoken in the mini-basin.

The goal of this project is to rehabilitate side sewers on 107 of 213 properties in BEL031. Because of steep slopes and other challenging topography in the mini-basin, there are limited properties that lend themselves to I/I rehabilitation. It will be critical to have as much participation as possible from the targeted property owners.

7.5.2 Issaquah Mini-Basin ISS003

Owners and residents of residential properties are the key target audience for this project in Mini-Basin ISS003. Preliminary research indicates the following:

- The entire basin is within Issaquah city limits.
- The majority of properties are single-family residences and condominium/apartment complexes.
- The area immediately to the east of the basin is zoned for retail uses. Construction impacts on local roads may be of interest to businesses in this area.
- English is the primary language spoken in the mini-basin, but there may be some households where Spanish is the primary language spoken.
- Issaquah Creek flows through the mini-basin. The community is very interested in the health of Issaquah Creek, particularly in its role as a salmon-bearing stream. The mini-basin is immediately adjacent to the Issaquah Salmon Hatchery on Issaquah Creek. Local citizens may have concerns about the impacts of I/I rehabilitation work on the creek.
- Tree preservation is important to this community.

The project goal is to rehabilitate side sewers on 113 of 133 properties in ISS003. It will be critical to have as much participation as possible from the targeted property owners.

7.5.3 Skyway Mini-Basin BLS002

Owners and residents of residential properties are the key target audience for this project in Mini-Basin BLS002. This mini-basin is located in unincorporated King County.

The Skyway Water and Sewer District collected ROE agreements and managed the side sewer rehabilitation work done as part of the 2003 pilot project. The project team needs to be aware of perceived surface water issues that have emerged since the pilot project was completed. Mini-Basin BLS002 is adjacent to the pilot project area and it is likely that some property owners in Mini-Basin BLS002 are aware of this problem.

Preliminary research indicates that English is the primary language spoken in the mini-basin, but that a small percentage of Skyway area residents do not speak English well. The project team will coordinate closely with the Skyway Water and Sewer District to identify the most appropriate methods of communication.

The project goal is to rehabilitate side sewers on 343 of 386 properties in BLS002. It will be critical to have as much participation as possible from the targeted property owners.

7.6 RISK MITIGATION

Risk assessment is the identification of potential events that would have a negative impact on a project. A risk analysis consists of three parts—risk identification, qualitative assessment of risk impacts and

probability, and quantitative risk assessment. Risk assessment for the Initial I/I Reduction project was developed by consensus of King County and design team staff at a series of workshops.

7.6.1 Risk Identification

Risk assessment workshop participants identified 48 potential risks for the proposed I/I removal improvements in the following general categories:

- Right of way, easement and property acquisition (six risks identified)
- Permit acquisition (four risks identified)
- Environmental and public impact (four risks identified)
- Engineering and design (four risks identified)
- General construction and sub-surface site issues (16 risks identified)
- Contracting (one risk identified)
- Public relations and community action (nine risks identified)
- Safety and security (one risk identified)
- Policy (three risks identified).

7.6.2 Qualitative Assessment of Probability and Impact

Workshop participants reviewed all identified risks and, by consensus, assigned each two qualitative ratings:

- Potential Impact Rating—The potential overall project impact of each risk was rated as low (L), medium (M) or high (H) based on consideration of how the risk would affect project cost, schedule, scope and quality.
- Probability Rating—The likelihood of each risk occurring was rated as low (L), medium (M) or high (H) based on workshop participants' experience.

7.6.3 Quantitative Risk Assessment

The quantitative assessment of risk-related cost was performed only for the risks that had received medium or high qualitative ratings for both potential impact and probability. For these risks, workshop participants assigned a specific percent probability of the risk occurring and then developed estimates of the potential cost associated with occurrence of the risk. This "impact cost" was multiplied by the risk's probability to calculate a "risk cost." The complete results of the risk identification, qualitative assessment and quantitative assessment are included in Appendix E.

7.6.4 Risk Mitigation

Risks can be mitigated by eliminating them, reducing their probability of occurrence, or reducing their potential impacts:

- Risk Elimination—Aggressive, proactive mitigation for high risks is essential to achieve the full benefits of risk management. It is preferred that critical risks be eliminated entirely, as they will have the greatest negative impact on the project. Risk elimination requires carrying out the necessary actions to completely remove the identified issue from the project.
- Risk Reduction—A reduction of the likelihood of occurrence or lessening of the impact can be attained by actions early in the project.

Suitable mitigation measures for risks with medium or high impact potential and probability were developed by the workshop participants. Table 7-4 lists these risks, their qualitative ratings, their risk cost, and potential mitigation measures.

7.6.5 Risk Mitigation Conclusions

Although a number of significant risks to achieving cost-effectiveness were identified, the consensus among King County staff, the project team and the E&P Subcommittee is that these risks are tolerable. One of the primary objectives of the Initial I/I Reduction projects is to prove whether I/I reduction can be cost-effective on a more large-scale basis than tested during the pilot projects. Project implementation will provide more definitive results on the validity of these risks and whether they can be overcome; and will provide a baseline for future I/I control efforts by the county.

7.7 RECOMMENDATION SUMMARY AND NEXT STEPS

The alternatives analysis identified two alternatives to be implemented as initial I/I reduction projects and estimated key costs and I/I reduction results for each:

- Eastgate/Issaquah Alternative BEL/ISS-B would rehabilitate 85 percent of laterals and side sewers in Mini-Basin BEL031 and 50 percent in Mini-Basin ISS003, at an estimated project cost of $5.23 million. The results of this project, depending on I/I reduction effectiveness, are estimated as follows:
  - 60-percent effectiveness—I/I reduction of 0.85 mgd; Eastgate Storage size reduction of 0.26 MG; Issaquah Storage size reduction of 0.37 MG; CSI project cost savings of $5.12 million
  - 75-percent effectiveness—I/I reduction of 1.04 mgd; Eastgate Storage size reduction of 0.32 MG; Issaquah Storage size reduction of 0.45 MG; Issaquah Interceptor size reduction of 0.59 mgd; CSI project cost savings of $6.37 million
- Skyway Alternative BLS-F would rehabilitate 89 percent of laterals and side sewers in Mini-Basin BLS002, at an estimated project cost of $5.63 million. The Skyway Water and Sewer District will contribute up to $260,000 to make this project cost-effective. The results of this project, depending on I/I reduction effectiveness, are estimated as follows:
  - 60-percent effectiveness—I/I reduction of 1.88 mgd; elimination of the Bryn Mawr Storage project; CSI project cost savings of $5.37 million
  - 75-percent effectiveness—I/I reduction of 2.29 mgd; elimination of the Bryn Mawr Storage project; CSI project cost savings of $5.37 million

TABLE 7-4.
MEDIUM- AND HIGH-RATED RISK ELEMENTS AND MITIGATION MEASURES

Risk Element	Probability /Impact Rating	Risk Cost	Potential Risk Mitigation / Response
Sufficient rights-of-entry for low and medium properties are not attained, requiring higher difficulty properties to be rehabbed, at a higher cost.	M/H	$183,040	• Obtain sufficient rights-of-entry to allow for addition of properties to reach reduction targets.
Sufficient rights-of-entry are not attained for the planned amount of private property rehabilitation. Project cannot proceed to implementation. (Skyway only)	H/H	$250,000	• Obtain sufficient rights-of-entry to allow for addition of properties to reach reduction targets.
I/I is not uniformly distributed across project areas as assumed; and reduction targets are not achieved in the project area.	M/H	$471,375 (Eastgate, Issaquah) $410,250 (Skyway)	• Work in additional areas to get a greater I/I reduction. Determine during design if this would be cost-effective. • Continue to compare I/I project to capital projects during design to check for cost-effectiveness.
I/I removal targets in mini-basins are achieved; however, a lesser reduction rate at the location of the downstream CSI project is realized because additional flows enter the system from other tributary areas	M/H (Eastgate, Issaquah) H/H (Skyway)	$471,375 (Eastgate, Issaquah) $820,500 (Skyway)	• Work in additional areas to get a greater I/I reduction. Determine during design if this would be cost-effective. • Continue to compare I/I project to capital projects during design to check for cost-effectiveness. • Obtain sufficient rights of entry to allow for addition of properties to reach reduction targets.
Peak I/I rates have been over-estimated in a mini-basin selected for implementation. Following rehabilitation, target reductions are not achieved (Eastgate & Issaquah)	M/M	$377,100	• Perform more metering throughout the mini-basin and refine the model. Ensure that modeling results have been verified with real-world rainfall and flow measurement data. • Work in additional mini-basins to get a greater I/I reduction. Determine during design if this would be cost-effective. • Continue to monitor and model flows during design to gain greater confidence in flow estimates. • Continue to compare I/I project to capital projects during design to check for cost-effectiveness.
High Bids	M/M	$210,000	• Early bid and award timing before contractors are booked for upcoming construction season. • Bid marketing, advance notice to contractors. • Structure bid packages to allow for release of smaller packages to more contractors if necessary.

Estimates and project details will be refined through the predesign process in 2009 and the final design in 2010. The predesign will identify exact parcels for rehabilitation and confirm the preferred construction method. During final design, contract documents will be prepared, rights of entry will be acquired, and the public participation program will be carried out. Construction of the projects will take place in 2011 and 2012.

As projects intended to demonstrate the feasibility of I/I reduction measures for future use county-wide, the Initial I/I Reduction projects will require detailed post-project evaluation to determine their effectiveness and identify the strengths and weaknesses of the approach developed in this alternatives analysis. The post-project evaluation will be performed in 2013, and will include the following:

- New flow monitoring will assess the actual impacts on I/I due to implementation of the recommended projects. King County staff will place flow meters in the mini-basins and monitor flow conditions over a winter season. The resulting data will be used to recalculate per-parcel I/I in each mini-basin and the net flow reduction at the upstream end of affected CSI projects. These results, together with final project costs, will be used to recalculate benefit/cost ratios. Unit costs for individual elements of the I/I reduction work, stormwater work required during or shortly after construction, and allied costs will be documented for the benefit of future I/I reduction projects.
- King County, local agency and design consultant staff will hold a debriefing meeting to assess the outcome of project implementation for each mini-basin. Lessons learned and comments from these meetings will be documented. The design consultant will prepare a post-project evaluation report providing a description of each initial project, and documenting lessons learned during the SSES and the alternatives analysis. Lessons learned will be documented and evaluated for their value to future King County I/I Program rehabilitation work. The report will present recommendations based on these lessons learned for application in future I/I reduction projects.
- A list of rehabilitated sewer system components for warranty inspection will be prepared, based on problems identified by local agencies, potential problems noted by construction inspectors during construction, and a random sampling of work done in all the project areas. An SSES contractor will perform the warranty inspections. This work will identify a list of defects and their severity so that repair work can be carried out. Defects and repairs will be identified and documented in a warranty inspection report. Warranty inspection and repairs will take place two years after completion of the Initial I/I Reduction projects.

Results of the post-project evaluation will be presented to the King County Executive for review in 2013, and the executive will submit recommendations to the County Council in 2013.

REFERENCES

King County. 2004. Pilot Project Report; Regional Infiltration and Inflow Control Program. King County Department of Natural Resources and Parks Wastewater Treatment Division. Seattle, Washington. October 2004.

King County. 2005a. Executive's Recommended Regional Infiltration and Inflow Control Program. King County Department of Natural Resources and Parks Wastewater Treatment Division. Seattle, Washington. December 2005.

King County. 2005b. Benefit/Cost Analysis Report; Regional Infiltration and Inflow Control Program. King County Department of Natural Resources and Parks Wastewater Treatment Division. Seattle, Washington. November 2005.

King County. 2007a. Conveyance System Improvement Program Update. King County Department of Natural Resources and Parks Wastewater Treatment Division. Seattle, Washington. June 2007.

King County. 2007b. Groundwater data, King County, Washington: Seattle, Wash., available: http://dnr.metrokc.gov/wlr/wq/groundwater-data.htm#.

King County. 2008. Initial I/I Projects Flow Monitoring Report. King County, Washington: Seattle, Wash. August 2008

King County Department of Natural Resources. 1998. King County groundwater management areas: Seattle, Wash., available: http://dnr.metrokc.gov/wlr/wq/pdf/9808groundwatermgtareas.pdf.

King County

Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report

APPENDIX A.
ENVIRONMENTAL TECHNICAL MEMORANDUM

April 2009

Environmental Technical Memorandum
King County Inflow and Infiltration Basin Study
King County, Washington

March 13, 2009

Submitted To:
Mr. Jeffrey Lykken
Tetra Tech
1420 Fifth Avenue, Suite 600
Seattle, Washington 98101

By:
Shannon & Wilson, Inc.
400 N 34th Street, Suite 100
Seattle, Washington 98103

21-1-20792-007

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (cont.)

Page

Page

LIST OF TABLES

Table No. **Page**

LIST OF FIGURES

Figure No.

LIST OF APPENDICES

Appendix No.

LIST OF ACRONYMS

ASTM	ASTM International
BEMP	Bald Eagle Management Plan
bgs	below ground surface
BMPs	Best Management Practices
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CSCSL	Confirmed and Suspected Contaminated Sites List
DMV	Department of Motor Vehicles
Dodds	Dodds Geosciences, Inc.
Ecology	Washington State Department of Ecology
EDR	Environmental Data Resources, Inc.
EPA	U.S. Environmental Protection Agency
ERNS	Emergency Response Notification System
FINDS	Facility Index System
GIS	Geographic Information System
I&I	Inflow and Infiltration
I-90	Interstate 90
ICR	Independent Cleanup Reports
KCC	King County Code
KCDNR	King County Department of Natural Resources
LUC	Land Use Code
LUST	leaking underground storage tank
NFA	No Further Action
NFRAP	No Further Remedial Action Planned
NGPA	Native Growth Protection Area
NGPE	Native Growth Protection Easement
NRCS	National Resource Conservation Service
PCBs	polychlorinated biphenyls
PHS	Priority Habitats and Species
RCRA	Resource Conservation and Recovery Act
RCRA-SQG	Resource Conservation and Recovery Act-Small Quantity
RCW	Revised Code of Washington
ROW	right-of-way
Spills	Spill Prevention, Preparedness and Response
SPU	Seattle Public Utilities
SQG	Small Quantity Generator
UST	underground storage tank
VCP	Voluntary Cleanup Program
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

KING COUNTY INFLOW AND INFILTRATION PROJECT STUDY
ENVIRONMENTAL TECHNICAL MEMORANDUM

This report describes the State Environmental Policy Act environmental concerns that we anticipate for the King County Inflow and Infiltration (I&I) project study in the Issaquah, Bellevue, and Skyway project areas. The Issaquah project area includes two mini-basins identified as ISS003 and ISS004. The Bellevue project area includes four mini-basins (BEL011, BEL012, BEL031, and BEL032). The Skyway project area includes three mini-basins (BLS001, BLS002, and BLS003).

The proposed project includes replacing and/or rehabilitating the sanitary sewer systems in the Issaquah, Bellevue, and Skyway project areas to alleviate infiltration leaks and peak flows in the sewer system. Work on private property would generally consist of rehabilitation and/or replacement of side sewers and installation of cleanouts. Work in the public right-of-way (ROW) would generally include the rehabilitation or replacement of main lines, service connections to the main line, laterals, and manholes. Construction techniques would include pipe bursting, pipe replacement, pipe lining, manhole rehabilitation, manhole replacement, cleanout installations, and disconnection or repair of direct connections (inflow sources) to remove groundwater and stormwater sources from the sewer system.

Each section of this report describes the potential environmental concerns associated with hazardous materials; wetlands, streams, and wildlife issues; landslide and erosion concerns; and groundwater systems for each project area.

1.0 ISSAQUAH PROJECT AREA (MINI-BASINS ISS003 AND ISS004)

1.1 Hazardous Materials Research

1.1.1 Site Description

The Issaquah project area is located southeast of Lake Sammamish and south of Interstate 90 (I-90) in King County. Most of the project area consists of residential properties on the east-facing slope of Squak Mountain. The eastern portion of the project area is relatively flat and dominated by a mixture of commercial and residential properties.

The study was conducted to evaluate if hazardous materials may be encountered during the proposed sewer upgrade project. The identified properties were ranked "low," "moderate," or "high" based on the likelihood of contaminants to be present in the soil in the vicinity of the sewer line and manholes where excavation may occur. Properties with known groundwater and/or soil contamination located near or adjacent to the sewer are considered to have a **high** potential for contaminating the soil in the vicinity of the sewer line. Adjacent businesses such as historical gas stations, historical automobile repair shops, dry cleaners, print shops, paint shops and photo shops where there are no known releases are considered to have a **moderate** potential for contaminating the soil. These types of businesses have commonly released contaminants into the soil and/or groundwater; however, where no evidence of a release has been observed or documented, the risk of contamination is evaluated to be **moderate**. Properties adjacent to sewer lines where reported petroleum or chemical spills of significant or unreported size have reached the soil are also considered to have a **moderate** potential to impact the project area.

Businesses, including gas stations and automobile repair shops developed since approximately 1988; construction companies with no known underground storage tanks (USTs); and residences with heating oil tanks are considered to have a **low** potential for contamination. Newer gas stations are considered to have a **low** contamination potential because of stringent regulations for UST construction, system installation, monitoring and testing. Although construction companies frequently have USTs, such companies are considered to pose a **low** potential for contamination where the presence of USTs has not been confirmed. Properties with heating oil tanks are considered to have a **low** potential because heating oil generally does not travel far in soil. The locations of the identified properties having a potential to impact soil in the vicinity of the sewer line are indicated in Figure 1.

1.1.2 Document Review

Local, State, and Federal Environmental Databases. Environmental Data Resources, Inc. (EDR) was subcontracted to conduct a search of available agency databases for sites within distances recommended by ASTM International (ASTM) for Phase 1 Environmental Site Assessments. The search included U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), Tribal, and local databases for known and suspected contaminated sites.

Four properties within the project area were identified as being on one or more of the following databases: spills reported to Spill Prevention, Preparedness and Response (Spills),

leaking underground storage tank (LUST), UST, Independent Cleanup Report (ICR), and Facility Index System (FINDS). These listed sites are shown in Figure 1 and are summarized below:

- **King County Fire District 10, 175 Newport Way NW, Issaquah (LUST, UST, ICR, Spills, FINDS).** The database information indicates that four USTs were removed from the property. Petroleum contamination in soil was found in November 1992, and cleanup was reportedly completed at that time. In February 1996, a separate spill of an unspecified quantity of diesel fuel to the soil was reported. The site is adjacent to the sewer line. Based on the reported diesel fuel spill to soil and the site's proximity to the sewer, the site is considered to have a **moderate** potential to impact soil excavation areas.
- **660 Wildwood, Issaquah (Spills).** According to King County Assessor information, apartments are located at this address. The agency database information indicates that spill incidents occurred in September 1995 and September 2003. The earlier spill was of an unspecified material to surface water, and the later one was of a chemical spill to "other" media. Neither spill report indicated quantity. Although the site is located adjacent to a sewer line, it is considered to have a **low** impact potential, because neither of the spill reports indicate that soil was impacted, and the site is not on other databases, which would have indicated that contamination is present.
- **Gilman Meadows Apartments, 360 NW Dogwood Street, Issaquah (Spills).** The spill incident report indicates that an unquantified hazardous material was spilled on the soil in January 2007. Because soil was reportedly impacted and there are multiple sewer lines on the property, the site is considered to have a **moderate** potential to impact the project area.
- **18 Mt. Pilchuck NW, Issaquah (Spills).** According to County Assessor information, this is a single-family residence. The Spills report indicates that sewage or sludge was spilled on the soil in December 2006. Unless sewage or sewage sludge is from an industrial source, it generally does not contain hazardous materials in significant quantities. Therefore, the site is considered to have a **low** potential to impact the project area.

Other sites listed outside of the project area were not considered a potential environmental concern because of the type of database listing and/or relative distance from the project area.

Cole's City Directories. City directories were reviewed at the Seattle Public Library for the years 1971 – 1972, 1977, 1981 – 1982, 1986 – 1987, 1991 – 1992, 1997, 2002, and 2007. The majority of the listings were residential, although some of the residential addresses are currently or were previously listed as home businesses. Home businesses of potential environmental concern include construction/contractor, ironworks, landscaping, carpet

installation, and painting. Based on the limited area of the listed home businesses, a database search for USTs, and visual observations of the properties during our site reconnaissance, it is unlikely that subsurface soils are contaminated above regulatory cleanup levels.

Other non-residential properties included a school, churches, a fish hatchery, and a fire station. The fire station is of **moderate** concern and is discussed in the Local, State, and Federal Environmental Databases section (Section 1.1.2). The fish hatchery is of low concern and is discussed in the King County Assessor records section. The other non-residential properties are not considered environmental concerns.

Sanborn Fire Insurance Maps. Sanborn Fire Insurance Maps were not available for the project area.

King County Assessor Records. Current Tax Assessor records were reviewed online at the King County iMap website. Tax assessor information prior to 1970 for this project was reviewed at the Puget Sound Regional Archives. Most of the parcels in the project area were residential, with 55 currently or historically using heating oil (Figure 1). Heating oil generally has low mobility when it has been released to subsurface soils. As a result, contamination is usually not widespread.

Other properties of concern were identified:

- Puget Sound Energy substation (constructed in 1962). The substation is located northwest of the Newport Way SW/W Sunset Way intersection. Substations may contain polychlorinated biphenyls (PCBs). This property is considered to have a **moderate** potential to impact the project area, because PCBs are relatively toxic and because two local sewer mains are located south and east of the property.
- A former gas station was located south of the Newport Way SW/W Sunset Way intersection. This property is now vacant land, and it is not known whether the gasoline USTs were removed and/or if a leak occurred. This property would typically be identified as a moderate risk, but because a local sewer main goes through the property, it is considered to have a **high** potential to impact the project area.
- A maintenance garage/shop constructed in 1952 is located on the fish hatchery property at 120 Newport Way SW. USTs are commonly located in or adjacent to maintenance garages to store used waste oil. This property is considered to have a **low** potential to impact the project area, because it appears that the maintenance garage is located on the eastern end of the property, more than 250 feet from the nearest sewer line in the project area.

- A fire station is located at 175 Newport Way SW. Fire stations commonly have USTs on their properties for vehicle refueling. This property is considered to have a **moderate** potential to impact the project area and is discussed further in the Local, State, and Federal Environmental Databases section (Section 1.1.2).

1.1.3 Site Reconnaissance

A visual reconnaissance of the project area was conducted on March 4, 2008. The project area is predominantly residential, with some commercial properties along W Sunset Way and Newport Way SW.

Properties of concern that were identified in the project area during our site reconnaissance include a substation northwest of the Newport Way SW/W Sunset Way intersection and a fire station at 175 Newport Way SW. Both of these properties are discussed in the King County Assessor's records section (Section 1.1.2).

1.1.4 Conclusions

The potential for impact to the sewer line from contaminated sites was evaluated based on the type of business, the proximity of the parcel to the sewer line, and the known or suspected presence of contaminants. In areas where the water table is at or above the sewer pipe elevation, the potential exists that the sewer trench backfill could be serving as a hydraulic conduit for contaminated groundwater migration. In such cases, it is possible that groundwater could carry contamination downgradient for considerable distances along the sewer line corridor. In addition, excavation and dewatering practices used during sewer line repair activities could create or modify contaminant migration pathways and/or distribution. However, this is unlikely because of the limited excavation and dewatering that is anticipated for this project.

The toxicity and cost of remediating contaminated soil that could be encountered during sewer line improvements varies depending on the type of contaminant. For example, dry cleaning solvents are highly toxic at low concentrations and remediation costs are typically very high. Other solvent contaminants resulting from businesses such as photo processing or printing shops may be less toxic than dry cleaning solvents but they can also result in high remediation costs. Soils contaminated with gasoline-range petroleum hydrocarbons generally have a lower toxicity and a lower disposal cost than soils contaminated with solvents, depending on the age of the gasoline. A more recent gasoline spill has more benzene, its most toxic component. The more benzene present in the soil, the higher the remediation costs. Older gasoline tends to be

less toxic and somewhat less expensive to remediate. Diesel- and oil-range petroleum hydrocarbons are the least toxic and least mobile petroleum contaminants and typically have the lowest cleanup costs. Metal contaminants could result in high remediation costs but, unlike the organic contaminants listed above, they do not easily absorb through the skin and have a relatively low health risk unless they are ingested.

Potential properties of concern are shown in Figure 1. Based on the environmental review, historical review, and site reconnaissance, the potential for impact from contaminants to the improvement of the sewer system appears to be **low to moderate** within the Issaquah project area, as summarized in Table 1.

TABLE 1
ISSAQUAH PROPERTIES OF CONCERN

Property	Location	Contaminant Potential	Contaminant(s) of Concern
Mini-Basin ISS003			
Residences with heating oil	Various (Figure 1)	Low	Petroleum products
660 Wildwood Boulevard	660 Wildwood Boulevard SW	Low	Unknown
Fish Hatchery Maintenance Garage	120 Newport Way SW	Low	Petroleum products
Former Gasoline Station	South of the Newport Way SW/ W Sunset Way intersection	High	Petroleum products
Mini-Basin ISS004			
Residences with heating oil	Various (Figure 1)	Low	Petroleum products
18 Mt. Pilchuck Avenue NW	18 Mount Pilchuck Avenue NW	Low	Sewage sludge
Gilman Meadows Apartments	360 NW Dogwood Street	Moderate	Unknown spilled material: screen for petroleum products, volatiles, and pesticides
Puget Sound Energy Substation	NW of the Newport Way SW/ W Sunset Way intersection	Moderate	PCBs
King County Fire District 10 Fire Station	175 Newport Way NW	Moderate	Petroleum products

PCB = polychlorinated biphenyls

We recommend that construction monitoring be performed where excavation is planned in areas of **low** potential for impact from contaminated sites (such as where spills have occurred and where USTs are suspected to be present). If contamination is identified, it would then be necessary to provide appropriate health and safety measures to protect site workers and to analyze the soil for proper disposal. Hazardous household materials such as cleaners, paints, and solvents are often disposed of in the sanitary sewer system from residences and businesses such as paint shops, printers, and photo developers. These materials can leak into the soil through sewer line joints. Also, sediments should be removed from manholes prior to work within them to reduce the risk of exposure to hazardous materials for site workers.

Based on the potential health risks associated with contaminated soil and groundwater, we recommend that earthwork be avoided in the vicinity of **moderate** and **high** risk sites. If earthwork cannot be avoided, we recommend that a Phase II Environmental Site Assessment be performed to determine whether contamination is present and to analyze the soil and/or groundwater for health and safety measures and proper disposal. Because the sites are not expected to be acquired by King County, the Phase II explorations should be confined to soil and/or groundwater sampling in the sewer line easement adjacent to each site. Sampling could be conducted with a Geoprobe® at intervals to the approximate depth of the sewer line. Soil samples should be analyzed for the appropriate contaminants of concern, as identified in Table 1.

1.2 Wetland, Streams, and Wildlife Research

1.2.1 Document Review

Washington State Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) Map. No priority habitats were mapped within the project area. Two areas immediately adjacent to the project area were mapped as priority habitat. Squak Mountain Park, located immediately southwest of mini-basin ISS003, is designated as urban natural open space and reported as containing diversely-vegetated, older- and second-growth, mixed forestland. The second priority habitat, located immediately northeast of mini-basin ISS004, is reported as riparian habitat. The riparian habitat is associated with Issaquah Creek and provides protection for fish habitat, as well as habitats for a large variety of avian and terrestrial species.

The PHS maps show several wetlands in the project area. Wetlands associated with Issaquah Creek were mapped south of Newport Way SW. Three wetlands were mapped in mini-basin ISS004, northeast of Newport Way SW and between W Sunset Way and Front Street

South. These wetlands correspond with the fish hatchery ponds. Another wetland was mapped in mini-basin ISS004, southwest of Newport Way NW, between NW Dogwood Street and NW Alder Court. Based on aerial photography and site reconnaissance, this wetland is no longer present, as this area is now developed.

Priority anadromous and resident fish presence is mapped in Issaquah Creek (both mini-basins) and in an unnamed stream (identified as Stream 11 in Figure 2) in mini-basin ISS003. Priority anadromous and resident fish in Issaquah Creek include Fall Chinook salmon, Coho salmon, Sockeye salmon, Winter Steelhead, Coastal Cutthroat trout, and Kokanee salmon. In addition, Coho salmon and resident Coastal Cutthroat trout are documented in the unnamed stream. These species are considered priority species by the WDFW.

The PHS maps identify tailed frog (*Ascaphus truei*) tadpoles approximately ¼ mile outside of the project area in a tributary to Issaquah Creek. Tailed frogs are listed as a state-monitored species and federal species of concern.

Washington State Department of Natural Resources (DNR) Natural Heritage Information System Database. No records for rare plant or high quality ecosystems were identified in the project area.

DNR Forest Practices Website. Issaquah Creek is mapped as a Type S water (both mini-basins). Eight tributaries to Issaquah Creek, classified as Type F and/or Type N waters, were mapped in ISS003. Three of these streams were not observed during our site reconnaissance and are either located in underground pipes or do not exist.

King County Critical Areas Map. Issaquah Creek is mapped as a Class 2 Salmonid stream (both mini-basins). Four unclassified tributaries to Issaquah Creek are mapped in mini-basin ISS003. No wetlands were mapped in the project area. No portion of the King County Wildlife Network is mapped in the project area.

King County Soil Survey. Soils in the project area were mapped in the King County Soil Survey as Kitsap silt loam, Alderwood gravelly sandy loam, Briscot silt loam, Beausite gravelly sandy loam, and Everett gravelly sandy loam. The Briscot silt loam soil series is considered hydric.

City of Issaquah Stream Inventory and Habitat Evaluation Report. Issaquah Creek is rated as a Class 1 stream (both mini-basins). Seven smaller streams in the project area are mapped as Class 2, Class 2 with salmonids, or Class 3 streams in mini-basin ISS003. Two additional streams are shown in mini-basin ISS003 but are not rated.

Four wetlands associated with Issaquah Creek, designated as IC-10, IC-11, IC-12, and IC-13, are mapped in mini-basin ISS003. IC-10 is shown as comprising two open-water wetlands associated with fish hatchery ponds. IC-11 and IC-12 are shown as small (approximately 0.1 acre), forested wetlands along Issaquah Creek. IC-13 is shown as a 59.8-acre wetland located along Issaquah Creek south of SW Clark Street, containing forested, scrub/shrub, emergent, and open-water elements. A 0.4-acre, forested wetland, identified as IC-9, is shown immediately north of mini-basin ISS004.

Fall Chinook salmon, Coho salmon, Sockeye salmon, winter steelhead, coastal cutthroat trout, and Kokanee salmon are reported in Issaquah Creek (both mini-basins). Cutthroat trout presence is reported in two other streams in mini-basin ISS003.

1.2.2 Site Reconnaissance

A reconnaissance of the project area was conducted on March 4, 2008. The project area is largely comprised of single- and multi-family homes with some commercial properties and community facilities along Newport Way NW and Newport Way SW, and occasional undeveloped lots.

Issaquah Creek was observed running north along the eastern boundary of both mini-basins. Twelve tributary streams, identified as Streams 1 through 12, were also observed in mini-basin ISS003 (Figure 2).

Several wetlands were observed in mini-basin ISS003. Forested riparian wetlands associated with Issaquah Creek were present south of Newport Way SW. North of Newport Way SW, the Issaquah Creek channel is incised and constricted by development. Riparian scrub/shrub wetlands were also observed associated with Streams 5, 11, and 12. In mini-basin ISS004, two culverts were observed to drain to a utility easement. Although the entire length of the easement was not walked, drainage patterns and the presence of hydrophytic vegetation indicated that a slope wetland is present along this easement.

Immediately north of mini-basin ISS004, a forested/scrub/shrub wetland was observed near the convergence of the east fork of Issaquah Creek and Issaquah Creek.

Two man-made depressions were observed in mini-basin ISS003, west of Sunrise Place SW and 1st Place SW. These depressions contained hydrophytic vegetation, but they are most likely storm ponds and not regulated as wetlands.

No raptors, raptor nests, or other priority habitats were observed during the site reconnaissance.

1.2.3 Conclusions

Wetlands and Wildlife. Wetlands were observed in mini-basin ISS003 along Issaquah Creek and in association with three other streams. One additional wetland was observed along a sloped utility easement in mini-basin ISS004. Wetlands were not categorized, but general buffer requirements are provided below. Both King County and the City of Issaquah wetland buffer width requirements depend on wetland classification based on the adopted Washington State Wetland Rating System for Western Washington, Ecology Publication Number 04-06-025, published August 2004. Issaquah's municipal code requires that wetland buffer widths range from 40 to 225 feet.

WDFW's PHS map shows priority fish presence in Issaquah Creek (both mini-basins) and Stream 5 (mini-basin ISS003). No other priority species were indicated by our document review or observed during site reconnaissance in the project area. Based on our review of Issaquah's municipal code, Issaquah does not have specific regulations regarding wildlife habitat conservation areas.

Streams. Issaquah Creek is located in both Issaquah mini-basins. Twelve additional streams, all tributaries to Issaquah Creek, were observed in mini-basin ISS003 (Figure 2). The City of Issaquah's stream classification system is primarily based on salmonid presence and seasonal flow. In accordance with Chapter 90.58 Revised Code of Washington (RCW), shorelines of the state are considered Class 1 streams under the City of Issaquah code. Streams used by salmonids are rated as Class 2 with Salmonid (2S) streams. Perennial streams without salmonids are rated as Class 2 streams. Intermittent or ephemeral streams without salmonids are Class 3 streams. Class 4 streams are those constructed or channelized, intermittent, without

salmonids or salmonid habitat, and not directly connected to a higher-class stream through an aboveground channel.

Issaquah Creek is identified as a "shoreline of the state," pursuant to Chapter 90.58 RCW, and is therefore regulated by the City of Issaquah as a Class 1 stream. Streams 1 (below Newport Way SW), 4, 5, 7 (below 1st Place SW), and 8 (below Sunrise Place SW) are likely regulated as Class 2S streams, as they appear to have sufficient flow and channel characteristics for salmonid presence and do not likely contain significant barriers to fish passage. However, identification of fish passage barriers was not part of our scope of work. Streams 1 (above Mountain Park Boulevard SW), 2, 7 (above 1st Place SW), and 8 (above Sunrise Place SW) are likely regulated as Class 2 streams, as they appear to be perennial and likely contain significant fish barriers. Streams 3, 6, 11, and 12 are likely regulated as Class 3 streams, as they are intermittent and likely do not contain salmonids because of insufficient flow, steep slopes, and fish passage barriers (roads). Streams 9 and 10 are likely regulated as Class 4 streams, as they have highly disturbed/created channels and are intermittent, and they appear to discharge to underground pipes below a residential development.

Issaquah's buffer width requirements are 100 feet for Class 1 and Class 2S streams, 75 feet for Class 2 streams, 50 feet for Class 3 streams, and 25 feet for Class 4 streams. Table 2 contains site stream classifications and standard buffer widths.

1.3 Landslide and Erosion Research

1.3.1 Geologic Conditions

Nearly the entire Issaquah study area is situated at the lower portions of the east-facing slope of Squak Mountain west of the Issaquah city center. Relatively flat topography of the Issaquah Creek alluvial plain characterizes the eastern portion of the project area. Several east-oriented tributary drainages to Issaquah Creek, separated by several prominent, steep-sided ridges, characterize the project area topography. In general, slope inclinations on the ridges range from 15 to 60 percent, while the slopes within the ravines range from 65 to steeper than 100 percent.

TABLE 2
ISSAQUAH STREAM CLASSIFICATIONS AND BUFFER WIDTHS

Stream	Mini-Basin	City of Issaquah	
		Classifications	Buffer Width (feet)
Issaquah Creek	ISS003 and ISS004	1	100
Stream 1 (*above Mountain Park Boulevard SW)*	ISS003	2	75
Stream 1 *(below Newport Way SW)*	ISS003	2S	100
Stream 2	ISS003	2	75
Stream 3	ISS003	3	50
Stream 4	ISS003	2S	100
Stream 5	ISS003	2S	100
Stream 6	ISS003	3	50
Stream 7 *(above 1st Place SW)*	ISS003	2	75
Stream 7 *(below 1st Place SW)*	ISS003	2S	100
Stream 8 *(above Sunrise Place SW)*	ISS003	2	75
Stream 8 *(below Sunrise Place SW)*	ISS003	2S	100
Stream 9	ISS003	4	25
Stream 10	ISS003	4	25
Stream 11	ISS003	3	50
Stream 12	ISS003	3	50

The Issaquah study area is underlain by Pleistocene glacial soils and Tertiary bedrock, according to published geologic maps (Booth et al., 2006b). The glacial soils in the project area consist of Vashon recessional deposits, till, advance outwash, and older, pre-Vashon, fine-grained clay and silt. Vashon recessional deposits, though deposited by glacial processes during the last (Vashon) glacial episode, were deposited during the wasting of the glacial ice and were not overridden by the Vashon ice sheet. The glacial recessional deposits may contain interbedded glaciofluvial sand and gravel, glaciolacustrine silt and clay, and/or ablation till. Glacially consolidated soils consisting of Vashon till and Vashon advance outwash mantle most of the slope in the northern portion of the project area. Vashon till is a very dense, gray, gravelly, silty sand of glacial origin that is commonly referred to as “hardpan.” Older,

pre-Vashon, fine-grained deposits of silt and clay underlie the advance outwash sand and gravel near the toe of the east-facing slope at the northern and southern portions of the project area.

West of the study area, and in the upper elevations to the south, bedrock of the Renton and Tukwila Formations forms the topographically high knobs and steep slopes. The Renton Formation conformably overlies the Tukwila Formation and includes the Renton coal measures, which were extensively mined throughout much of the Newcastle Hills in Renton and Issaquah in the late 19th and early 20th centuries. Most of the Renton Formation consists of fine- to medium-grained arkosic sandstone with siltstone, shale and coal seams. The Tukwila Formation is composed of silty sandstone and sandy siltstone with interbeds of andesitic lava flows (Walsh, 1984). The Renton or Tukwila Formations may also underlie glacial soils at shallow depths where the two units are mapped close to each other.

Soils within the relatively flat floodplain of Issaquah Creek in the eastern portion of mini-basin ISS004 include fill soils overlying Holocene alluvium consisting of interbedded silt, fine sand, and gravel. Existing subsurface information reviewed for this study indicates groundwater depths as shallow as 4 feet below ground surface (bgs).

Holocene mass wastage soils (colluvium and/or landslide deposits) are mapped at the southern end of the project area along the toe of the east-facing slope. The mass-wastage deposits are found directly downslope of the contact between the advance outwash sand and gravel and the underlying pre-Vashon silt and clay deposit. Although not mapped in the vicinity of W Sunset Way, mass-wastage deposits are also likely to exist where sand and gravel overlies clay and silt.

Intensive underground coal mining in the late 19th and early 20th centuries occurred in the southern portion of the project area, in the vicinity of Wildwood Boulevard SW. Coal mine-related subsidence features have been documented in several geotechnical engineering reports reviewed for this project, as well as in historical newspaper articles. Historically, many of the collapse features were backfilled with various available materials including old cars, stumps, refuse, tires, mine spoil, and boulders. Additionally, several shafts, portals, and gangways (including drainage tunnels) exist in the Wildwood Boulevard SW vicinity. Elsewhere in the project area, many of the steep slopes have been modified by residential housing construction, street grading, and park development. The following sections describe the observations made during reconnaissance of each of the Issaquah mini-basins.

Mini-basin ISS003. West of SW Mount Baker Drive, 60 to 100 percent slopes bound a bowl area with wet ground, seepage, and evidence of soil creep. The head of the bowl is due west of Mount Defiance Circle SW. Trees within the bowl are mostly deciduous, with scattered cedars. Several leaning/tilting trees and trees with bowed trunks were observed within the bowl area.

South of the bowl area described above, the Mount Defiance Circle SW area is developed with residential housing terraced into the east-facing slope. Fill and cut slopes range in inclinations between 75 and 100 percent. Minor seepage was observed along the shoulder of a newly paved utility easement. No evidence of instability was observed in this area. Bounding the southern side of the Mount Defiance Circle SW area and outside the mini-basin is an east-flowing tributary drainage with 75 to 85 percent slopes exhibiting signs of shallow colluvial sloughing and soil creep.

South of the intersection of Newport Way SW and Wildwood Boulevard SW, the ground surface topography exhibits signs of modification, including fills and excavations related to historical mining activity and relatively recent residential and commercial development. Existing subsurface information reviewed for this project reveals the presence of mine spoils throughout the southern portion of the mini-basin.

In general, the ground surface of the mini-basin area adjacent to Issaquah Creek is inclined to the east at 15 to 30 percent. Steep, 55 to 75 percent fill slopes are present adjacent to relatively recent residential developments located between Sunrise Place West and Issaquah Creek. Instability in the form of soil creep and slumping was observed along the trail within the utility easement adjacent to Issaquah Creek. Based on soils observed within the open ditchline at the toe of the slope and on the slope surface, the instability appears to be mobilizing Wildwood Boulevard SW fill soils, mine spoils, and colluvium. Abundant seepage emerges from the slope toe, and drainage water flows from pipes adjacent to the trail. Some of the drainage water was iron-oxide stained and had a sulfur odor, which could be related to former mining activity. Slope instability related to unmapped, buried drainage tunnels along Wildwood Boulevard SW was noted in the existing geotechnical literature.

The utility easement located south of the Sunrise Place SW cul-de-sac crosses at least two east-flowing tributaries to Issaquah Creek. Culverts associated with the stream crossings appear

to have been improved recently (in 2008), and erosional evidence on and downslope of the trail indicate that the culverts may have been previously overtopped and/or plugged.

Mini-basin ISS004. Abundant seepage and slopes inclined between 50 and 70 percent exist in a bowl-shaped area east of Sunset Court NW. Standing water was observed in the utility easement extending between W Sunset Way and the head of the bowl to the north. Several bowed and/or tilting alder and cedar trees were observed within the axis of the bowl. The 65 to 75 percent, east-facing, undeveloped slope continues north of the bowl area, subparallel to Newport Way NW, and outside of the mini-basin.

Modified ground related to residential development exists along Dorado and Capella Drives NW, and little evidence of slope instability was observed in this area during our visits. However, seepage was noted issuing from the sidewalk areas at the intersection of Dorado and Capella Drives NW. Upslope of the intersection, wet ground and abundant seepage exists within an east-facing bowl off the dead end of Almak Court NW. The surface water from this bowl appears to be contributing to the seepage noted downslope along the sidewalks of Capella and Dorado Drives NW.

A back-tilted 36-inch-diameter fir tree is located within the axis of a subtle, northwest-facing swale between the dead end of Big Bear Court NW and W Sunset Way. Abundant seepage and associated wet ground were observed in this area during our visit. Other than the back-tilted fir tree, no other signs of instability were noted in the field. To the west, existing geotechnical literature notes the presence of potential instability around the existing municipal water tanks where landslide debris was encountered over pervious sand and gravel interbedded with silt and clay.

A minor amount of seepage exists along Big Bear Place NW, specifically at the intersection with W Sunset Way where water was observed seeping from around an existing drain inlet. The ground surface in the vicinity of Big Bear Place NW and areas to the east, including Aires Place NW, Mount Olympus Drive NW, and Mount Pilchuck Avenue SW, is modified with housing developments, and little to no indicators of slope instability were observed in the area.

Documented slope instability related to residential construction along Mount Quay Drive NW, near the western boundary of the mini-basin, was noted in the existing geotechnical literature. Seepage was observed at the dead ends of Mount Rainier and Mount Si Places NW,

upslope of the landslide area. Subsurface explorations performed for the mitigation of the instability indicate fill soils over a thin veneer of older landslide debris overlying glacial till.

1.3.2 Presence or Proximity to Mapped Geologic Hazards

The entire Issaquah project area is situated within the Issaquah city limits. The City of Issaquah does not currently have citywide critical areas maps. However, based on the definitions in the City of Issaquah Critical Areas Regulations, landslide hazards exist in most of the project area below elevation 400 feet for one of three main conditions:

- Slopes greater than 40 percent.
- Areas with a combination of:
  - Slopes greater than 15 percent
  - Impermeable soils (typically silt and clay) frequently interbedded with granular soils (predominantly sand and gravel)
  - Springs or groundwater seepage
- Areas exhibiting evidence of movement during the Holocene epoch (from 10,000 years ago to present) or underlain by mass-wastage deposits.

Erosion hazard areas regulated by the City of Issaquah consist of those areas mapped by the National Resource Conservation Service (NRCS, formerly the U.S. Department of Agriculture Soil Conservation Service) as having a “severe” or “very severe” erosion hazard. Soils exhibiting a severe or very severe erosion hazard within the project area include:

- Alderwood gravelly sandy loam, 15 to 30 percent slopes
- Beausite gravelly sandy loam, 15 to 30 percent slopes
- Kitsap silt loam, 15 to 30 percent slopes

Based on the NRCS soils map of the project area, erosion hazards exist along portions of Sunrise Place SE, Mount Quay Drive SW, the steep east-facing slope west of Newport Way NW, and in the vicinity of Mount Defiance Circle SW.

Steep slope hazard areas, as defined by slopes of 40 percent or greater, are also not mapped and are ubiquitous throughout the Issaquah project area.

Based on City of Issaquah Critical Areas definitions, reviewed geotechnical information, and King County Sensitive Areas maps, the entire Issaquah project area south of Mountain Park

Boulevard SW is classified as a coal mine hazard area. General topographic observations made during our field reconnaissance are consistent with the mapped coal mine hazard.

No seismic hazard areas are indicated on the King County Sensitive Areas maps within the Issaquah project area. However, considering that the City of Issaquah defines seismic hazard areas as those areas underlain by cohesionless soils of low density with a high groundwater table, portions of the project area situated within the Issaquah Creek alluvial plain could be considered seismically hazardous.

1.3.3 Conclusions

The potential for inducing landsliding or erosion in most of the Issaquah project area by reducing I&I is low to negligible. However, in some areas previously and subsequently discussed, and illustrated in Figure 3, the potential is moderate to high, if I&I is currently being directed into sewer lines in these zones:

- The bowl area located north and east of W Sunset Way, in the vicinity of Sunset Court NW (ISS004, **Area 1**).
- The bowl area between the Almak Court NW and Dorado Drive NW dead ends (ISS004, **Area 2**).
- The Mount Quay Drive NW area of historical instability (ISS004, **Area 3**).
- The bowl area between Mount Defiance Circle NW and SW Mount Baker Drive (ISS003 and ISS004, **Area 4**).
- The area east of Wildwood Boulevard SW between SW Clark Street and Sunrise Place SW (ISS003, **Area 5**).

Improvements to reduce I&I could cause the groundwater levels to rise, thereby increasing the risk of landslides. While we understand that the pipe-bursting method proposed for this project greatly reduces the amount of ground disturbance relative to trenching, the ground surface around maintenance holes located in steep, undeveloped ROW could be disturbed and may engender erosion in the erosion hazard areas, if Best Management Practices (BMPs) are not followed during construction.

Based on our review of the maps, we understand that all of the utility components included in this project area lie within the City of Issaquah; therefore, City of Issaquah development standards apply to the planned improvements.

The City of Issaquah Critical Areas Regulations require a 50-foot setback from steep slopes (greater than 40 percent) or from all edges of identified landslide hazard areas. An additional 15-foot setback from the 50-foot buffer is required for structures. Exemptions from the setback requirement may be granted if studies by a licensed geologist or geotechnical engineer indicate that the landslide hazard could be mitigated or eliminated. On the other hand, the ordinance allows an exemption for normal and routine maintenance or repair of existing utility structures, if performed in compliance with permitting requirements.

1.4 Groundwater Systems Research

1.4.1 Groundwater Setting

Issaquah is located in the Issaquah Creek Valley groundwater management area (KCDNR, 1998). East of Newport Way NW, the Issaquah project area is located in a wellhead protection area (King County, 2007). In mini-basin ISS004, around Big Bear Place NW and Mount Fury Circle SW, the areas are mapped as having a medium susceptibility to groundwater contamination; this is in the general vicinity of the glacial advanced outwash deposits (King County, 2007).

The use and protection of groundwater in the Issaquah project area is governed by several local agencies. Drinking water is managed by the Cascade Water Alliance.

1.4.2 Physiographic Setting

The project area slopes downward, eastward to northeastward from a northwest-southeast-trending ridge. In the parts of the project area farthest east, the topography is relatively flat. Elevations rise as high as 550 feet in the farthest western area, and drop to elevation 80 feet in the northeastern project area.

Mini-basin ISS004 consists of Fraser Glaciation and Vashon Stade deposits, mainly glacial till, with glacial advanced outwash deposits found in the north-central part of the project area (Booth, et al., 2006b). There is also evidence of ice contact deposits and pre-Vashon fine-grained deposits in the north-central section of the project area. The lowlands to the east, along Newport Way, are alluvium deposits (Booth, et al., 2006b). In mini-basin ISS003, in the vicinity of Mine Hill Road and Wildwood Boulevard SW, the geology consists of modified ground from coal-mining activities (Golder and Associates, Inc., 1989 and 1994). In the southern end of mini-basin ISS004, scattered mass-wasting deposits of colluvium are found along bases of the

slope in residential, construction-altered terrain. Additional discussion of the geology can be found in the Geologic Conditions section (Section 2.3.1).

1.4.3 Site Reconnaissance

A drive-by reconnaissance of mini-basins ISS003 and ISS004 was conducted on February 29, 2008. In general, the project area is predominately single-family homes with yards. Multiple condominium and apartment developments have been constructed around the intersection of Newport Way NW and W Sunset Way in both mini-basins. Sidewalks border some arterial streets but are absent in cul-du-sacs. Multiple streams appear in the northern, eastern, and southern parts of the project area, some with wetlands scattered near streams. Additional discussion on streams and wetlands can be found in the Wetlands, Streams, and Wildlife Review section (Section 2.2) of the report. Ravines and landslide scarps are noted in the Geologic Conditions section (Section 2.3.1).

Stormwater catch-basin ditches with standing water were found in mini-basin ISS003 on Mt. Defiance Circle SW, SW Mt. Baker Drive, and Hillside Drive SE, indicating a potential impact on shallow groundwater through water infiltration.

Groundwater seeps were found in abundance in the northwestern end of mini-basin ISS004, off of W Sunset Way, Sunset Court NW, Big Bear Place NW, Capella Drive NW, El Dorado Drive NW, Almak Court NW, Mt. Rainer Place NW, and Mt. Si Place NW (Figure 4). Additional seeps were found off of Mount Park Boulevard SW and Mount Defiance Circle SW in mini-basin ISS003. Minor seeps located in the southern end of mini-basin ISS003 were found emerging from the slope along Hillside Drive SE. In our opinion, seeps are an indication of shallow or perched groundwater.

1.4.4 Groundwater Occurrence

Shallow groundwater, as indicated by numerous seeps, is frequent in mini-basin ISS004; these seeps are located in an area of coarse-grained, glacial advanced outwash deposits. Groundwater appears to be collecting in the glacial advanced outwash deposits and perching on underlying, finer-grained, pre-Vashon deposits. Where the fine-grained perching layer intersects the ground surface, seeps could occur. In mini-basin ISS003, groundwater seeps are present in colluvium, again likely perching on a less pervious base layer.

From the NW Geomaps search, we identified geotechnical reports from multiple developments along the lowland eastern area of the mini-basins. From our review of these reports, we understand that test pits at 420 Newport Way NW encountered groundwater seepage between 4 and 10 feet bgs, and are likely a good representation of shallow groundwater conditions in the alluvial valley (AGRA Earth & Environment, Inc., 1996).

Mini-basin ISS003 contains areas of former mining activity. These include Mine Hill Road and east of Wildwood Boulevard SW, where groundwater seepage has been reported emerging from the hillside following a landslide, and groundwater was encountered in borings at 5 to 11.5 feet bgs (Golder Associates, Inc., 1989). Farther south in the former mining area, in the vicinity of Wildwood Boulevard SW and Sunrise Place SW, groundwater was encountered between 22 and 24 feet bgs (Golder Associates, Inc., 1994).

We reviewed our project files for the lower Issaquah Valley and identified a surficial aquifer approximately 10 to 80 feet bgs. The aquifer was also encountered in the City of Issaquah's explorations for a production well just east of Newport Way NW (Golder Associates, Inc., 2000).

1.4.5 Ecology Well Logs

Well records and drilling logs were collected from Ecology for the Issaquah mini-basins and immediate surrounding areas. Specific areas included Township 24 North, Range 6 East, Sections 28, 33 and 34, and Township 23 North, Range 6 East, Section 3. Well logs provide depth-to-water information for Table 3 in the following section.

1.4.6 Depth to Water

The depth to groundwater generally depends on the presence of perching layers in relation to the ground surface in the upland areas, and the presence of surface water bodies in the lowland areas.

TABLE 3
GROUNDWATER DEPTHS – ISSAQUAH PROJECT AREA

Township, Range, Section	Location	Depth to Water	Date
24, 6E, 34 (east)	Front Street and Lewis Street SE	7	March 2005
24, 6E, 34 (east)	515 Front Street	3	November 2007
24, 6E, 28 (east)	30 W Sunset Way	8, 18.5, 24	1989, 1997, 1992
24, 6E, 28 (east)	19 1st Place NW	27	June 1992
24, 6E, 28 (east)	NW Dogwood Street and 1st Place NW	15	November 1998
24, 6E, 28 (north)	730 NW Gilman Boulevard	5.5, 6, 7.5	February/April 2004
24, 6E, 28	(Not indicated)	125	October 1954

Note: The depth to groundwater in the project area was identified from Washington State Department of Ecology Well Records.

1.4.1 Water-level Fluctuations

No specific water-level fluctuation data were identified. However, based on experience in similar locations, groundwater perching on low-permeability soil would likely fluctuate seasonally, with less water present during the summer and fall and more water present during the winter and spring or following prolonged rainfall events.

Groundwater in the alluvium deposits would likely fluctuate seasonally in direct relationship to the elevation of Issaquah Creek.

1.4.2 Groundwater Flow Direction

In general, groundwater flows with topography to the northwest, flowing toward Lake Sammamish (KCDNR, 2005). Locally, the direction of groundwater flow could be influenced by variability in soil conditions, the presence of surface water, and subsurface structures, including utility trenches.

1.4.3 Conclusions

Alluvium deposits in the eastern part of the project area are most likely in hydraulic connection with Issaquah Creek, and significant amounts of groundwater could be encountered near Issaquah Creek. Excavation activities near Issaquah Creek could require construction dewatering to control groundwater inflow in test pit areas associated with pipe-bursting activities. In both mini-basins, pipe-bursting activity could cause groundwater pressures to rise

around the bursting head, making the saturated soils more fluid. In this area, construction methods used in pipe bursting should control soil brought by groundwater inflow between the burst and replacement pipes, to prevent locking of the pipes during installation.

In the northwestern part of mini-basin ISS004, groundwater seeps from the glacial advanced outwash deposits are seen entering storm drains, so a small amount of sewer flow is currently caused by infiltration. Groundwater could be present in significant amounts in these glacial advanced outwash deposits. Groundwater in the deposits might need to be controlled with dewatering activity around test pits associated with pipe-bursting activities. Construction methods should also control soil and groundwater inflow between pipes during construction.

In the mine-altered ground found in mini-basin ISS003, excavation activities could require limited to significant dewatering activities because of the variable nature of the backfill. The mining activity included drainage tunnels, indicating that groundwater is present in the area.

Small accumulations of groundwater could perch atop the glacial till or exist within coarse-grained lenses in till and ice-contact deposits. Groundwater in these areas could contribute seasonally to sewer infiltration but likely would not pose significant problems during excavation activities, and only limited construction dewatering could be necessary in the vicinity of the test pits.

Locally perched groundwater lenses are unlikely to provide a large portion of base flow to local streams.

With the Issaquah project area being located in a groundwater management area for both mini-basins, and with the presence of a wellhead protection area east of Newport Way NW for mini-basin IS004, coordination with local regulatory agencies could be necessary. King County and the City of Issaquah regulate the groundwater management area while the King County Department of Health is responsible for the wetland protection area. In both cases, notification is required for work in both areas and the use of BMPs may be required to protect groundwater resources.

2.0 BELLEVUE PROJECT AREA (MINI-BASINS BEL011, BEL012, BEL031, AND BEL032)

2.1 Hazardous Materials Research

2.1.1 Site Description

The Bellevue project area is located between Lake Washington and Lake Sammamish, and south of the I-90 corridor in King County. The project area consists of residential properties on north-facing hillsides that slope to the commercial area near the I-90 corridor in the northern part of mini-basin BEL012.

This study was conducted to evaluate if hazardous materials could be encountered during the proposed sewer upgrade project. The identified properties were ranked **low**, **moderate**, or **high**, based on the likelihood of contaminants to be present in the soil in the vicinity of the sewer line and manholes where excavation could occur. Properties with known groundwater and/or soil contamination located near or adjacent to the sewer are considered to have a **high** potential to contaminate the soil in the vicinity of the sewer line. Adjacent businesses, such as historical gas stations, historical automobile repair shops, dry cleaners, print shops, paint shops, and photo shops where there are no known releases are considered to have a **moderate** potential to contaminate the soil. These types of businesses have commonly released contaminants into the soil and/or groundwater; however, where no evidence of a release has been observed or documented, the risk of contamination is considered to have a **moderate** potential. Properties adjacent to sewer lines where reported petroleum or chemical spills of significant or unreported size have reached the soil are also considered to have a **moderate** potential to impact the project area.

Businesses, including gas stations and automobile repair shops developed since approximately 1988; construction companies with no known USTs; and residences with heating oil tanks are considered to have a **low** potential to impact the project area. Newer gas stations are considered to have a **low** contamination potential because of the implementation of stringent regulations for UST construction, system installation, monitoring, and testing. Although construction companies frequently have USTs, such companies are considered to pose a **low** potential for contamination where the presence of USTs has not been confirmed. Properties with heating oil tanks are considered to have a **low** potential because heating oil generally does not travel far in soil. The locations of the identified properties that have a potential to impact to soil in the vicinity of the sewer line are indicated in Figure 5.

2.1.2 Document Review

Local, State, and Federal Environmental Databases. EDR was subcontracted to conduct a search of available agency databases for sites within distances recommended by ASTM for Phase 1 Environmental Site Assessments. The search included EPA, Ecology, Tribal, and local databases for known and suspected contaminated sites.

Eleven properties within the project area and one Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) No Further Remedial Action Planned (NFRAP) site within one mile of the project area boundary were identified as being on one or more of the following databases: Spills, LUST, UST, ICR, Resource Conservation and Recovery Act (RCRA) Small Quantity Generator (SQG), Confirmed and Suspected Contaminated Sites List (CSCSL) No Further Action (NFA), Volunteer Cleanup Program (VCP) and FINDS. The CERCLIS-NFRAP site (former Eastgate Landfill) was also on the CSCSL and Institutional Control Site List databases.

These listed sites are shown in Figure 5 and are summarized below:

- **Tosco Corporation Site 2564273, 15220 SE 36th Place, Bellevue (CSCSL NFA, VCP, ICR, FINDS, RCRA-SQG).** The database information indicates that petroleum-contaminated soil was observed during the removal of three USTs in 1998. Following remediation, Ecology issued a NFA status (5/12/2005). Site soil has been remediated and groundwater was reportedly not affected. Therefore, the site is evaluated to have a **low** potential to impact the project area.
- **Eastgate Plaza 24 Hour Custom Cleaner, 15100 SE 38th Street, Bellevue (FINDS, RCRA, Inactive Drycleaner).** The drycleaner in the Eastgate Plaza shopping center is listed on databases that indicate hazardous chemicals are or were stored on site. A gas station is also located on this property but is not considered a risk to the project because it is located 1,000 feet to the east. Although the dry cleaner is not listed on a database that would indicate that a release of hazardous materials has occurred, the property is still considered to have a **moderate** potential to impact the project area because dry cleaning fluids (solvents) are highly toxic at low concentrations.
- **Seattle Public Utilities (SPU) Eastside Reservoir, 4404 146th Avenue SE, Bellevue (FINDS).** Ecology's information indicates that the facility stores hazardous chemicals and reports annually for emergency preparedness planning. Inclusion on this database does not indicate that a release of hazardous materials has occurred. Therefore, this site is considered to have a **low** potential to impact soil in the project area.
- **South Bellevue Community Center, 14509 SE Newport Way, Bellevue (Spills).** The spill incident report indicates that 60 gallons of diesel fuel spilled to soil in March 2005.

-basin BEL032. It **w** potential to impact the project area, because the spill report indicates that soil was impacted.

- **Hewlett-Packard Company, 15815 SE 37th Street, Bellevue (UST, RCRA-SQG, CSCSL NFA, VCP, ICR, FINDS).** The database information indicates that five USTs were removed from the site. Petroleum products and metals-impacted soil and groundwater were observed during UST removal. Following remediation, Ecology issued a NFA status (4/27/2000). Site soil and groundwater have reportedly been remediated; however, the site is evaluated to have a **moderate** potential to impact the project area.
- **Hotel, 15805 SE 37th Street, Bellevue (Spills).** The Spills report indicates that an unspecified quantity of oil spilled on the paved roadway in July 2001. Based on the material spilled and no indication that soil was impacted, the site is evaluated to have a **low** potential to impact the project area.
- **Washington Environmental Pro T, 4017 162nd Avenue SE, Bellevue (RCRA-SQG, FINDS).** The RCRA database information indicates that no violations were found. Inclusion on the RCRA database does not indicate that a release of hazardous materials has occurred. Therefore, the site is considered to have a **low** potential to impact the project area.
- **Comcast Cable Communications Bellevue, 3622 156th Avenue SE, Bellevue (FINDS).** Ecology's information indicates that the facility stores hazardous chemicals and reports annually for emergency preparedness planning. Inclusion on this database does not indicate that a release of hazardous materials has occurred. Therefore, this site is considered to have a **low** potential to impact the project area.
- **Arrow Lumber, 16343 SE 40th Street, Bellevue (Spills).** The Spills report indicates that two quarts of hydraulic oil spilled on a paved roadway in July 2002. Based on the material spilled and no indication that soil was impacted, the site is evaluated to have a **low** potential to impact the project area.
- **5101 145th Place SE, Bellevue (Spills).** The Spills report indicates that 20 gallons of a petroleum product spilled on a paved roadway in January 2000. Although the site is located adjacent to a sewer line, it is considered to have a **low** potential to impact the project area because the spill report does not indicate that soil was impacted, and the site is not on other databases that would indicate that contamination is present.
- **Theil Collins residence, 5215 146th Avenue SE, Bellevue (CSCSL NFA, VCP, FINDS).** Ecology's database information indicates that this site was granted NFA status on December 29, 2004, following remediation. The site is located just outside of the project area, and not in proximity to sewer lines scheduled for work. Based on the site's cleaned-up status and its location, it is considered to have a **low** potential to impact the project area.

The former Eastgate Landfill site (2805 160th Avenue SE) is located approximately one-half mile north of the closest project boundary. The database information indicates that groundwater is known to have been impacted by non-halogenated solvents, priority pollutant metals/cyanide, and conventional organic and inorganic contaminants. These and other contaminants are suspected in surface water and soil. Remedial action is in progress, and a restrictive covenant has been filed limiting property, soil, and groundwater use. Based on the site's distance and location downgradient relative to the project area, this site is not considered a risk to the project area.

Other sites listed outside of the project area were not considered a potential environmental concern because of the type of database listing and/or relative distance from the project area.

Polk and Cole's City Directories. Polk city directories were reviewed at the Seattle Public Library for the years 1964 – 1965, 1970, 1975, 1980 and 1985. Cole's city directories were reviewed at the Seattle Public Library for the years 1990 – 1991, 1994 – 1995, 2000, and 2005.

The majority of the listings were residential but also included schools, churches, daycares, and a reservoir. These non-residential properties are not considered an environmental concern with the exception of the reservoir, which is of low concern and is discussed in the Local, State, and Federal Environmental Databases section (Section 2.1.2).

Other residential addresses that currently or previously were listed as home businesses include construction/contractors; carpet cleaning, landscaping, painting, and handyman services; roofing; stained glass production; and a photographer. Based on the limited area of the listed home businesses, database searches for USTs, and visual observations of the properties during our site reconnaissance, it is unlikely that subsurface soils are contaminated above regulatory cleanup levels.

At 4642 159th Avenue SE, a property was listed as a business called Brake Stop in the 1994 directory listing; however, the property is not listed in our UST search and is located on a residential parcel. This property is not considered a risk to the project because the brake shop was listed for only one year, and it is unlikely that a brake repair shop was actually located on this residential property.

Commercial properties are present on SE 37th Street, and on 156th Avenue SE. Schuck's Auto Supply (15303 SE 37th Street) and the Department of Motor Vehicles (DMV) Vehicle Emissions Testing facility (15313 SE 37th Street) are the only property uses of concern; however, the Hewlett-Packard Company, Comcast Cable Communications Bellevue, and Bellevue Studio Hotel are properties of concern because of their listings on Local, State, and/or Federal Environmental Databases section (Section 2.1.2).

Sanborn Fire Insurance Maps. Sanborn Fire Insurance Maps were not available for the project area.

King County Assessor Records. Current tax assessor records were reviewed online at the King County iMap website. Tax assessor information prior to 1970 for this project was reviewed at the Puget Sound Regional Archives. The parcels in the project area were generally listed as residences, of which 56 currently or historically used heating oil (Figure 5). Heating oil has generally low mobility when it has been released to subsurface soils. As a result, contamination, if any, is usually not widespread. Other properties of concern include Schuck's Auto Supply (built in 1975); the DMV vehicle emissions testing facility, listed as a service garage and built in 1982; and the drycleaners located at the Eastgate Plaza shopping center, built in 1972.

2.1.3 Site Reconnaissance

A visual reconnaissance of the project area was conducted on March 3, 2008. In general, the project area is predominantly comprised of single-family homes. Commercial properties are located on the northern section of the project area, along SE 37th Street and 156th Avenue SE. Commercial properties of concern that were identified in the project area during our site reconnaissance included:

- Schuck's Auto Supply, located at 15303 SE 37th Street. Auto supply shops typically store used motor oil in drums, which are then picked up by a waste disposal company.
- 76 Gas Station, located at 15220 SE 37th Street (referred to as Tosco Corporation Site 2564273 in Section 2.1.2.

2.1.4 Conclusions

The potential for impact to the sewer line from contaminated sites was evaluated based on the type of business, the proximity of the parcel to the sewer line, and the known or suspected

presence of contaminants. In areas where the water table is at or above the sewer pipe elevation, the sewer trench backfill could be serving as a hydraulic conduit for contaminated groundwater migration. In such cases, it is possible that groundwater could carry contamination for considerable distances downgradient along the sewer line corridor. In addition, excavation and dewatering practices used during sewer line repair activities could create or modify contaminant migration pathways and/or distribution. However, this is unlikely because of the limited excavation and dewatering anticipated for this project.

The toxicity and cost of remediating contaminated soil that could be encountered during sewer line improvements varies depending on the type of contaminant. For example, dry-cleaning solvents are highly toxic at low concentrations, and remediation costs are typically very high. Other solvent contaminants resulting from businesses such as photo processing or printing shops may be less toxic than dry-cleaning solvents but can also result in high remediation costs. Soils contaminated with gasoline-range petroleum hydrocarbons generally have a lower toxicity and a lower disposal cost than soils contaminated with solvents, depending on the age of the gasoline. A more recent gasoline spill has more benzene, its most toxic component. The more benzene present in the soil, the higher the remediation costs. Older gasoline tends to be less toxic and somewhat less expensive to remediate. Diesel- and oil-range petroleum hydrocarbons are the least toxic and least mobile petroleum contaminants and typically have the lowest cleanup costs. Metal contaminants could result in high remediation costs, but unlike the organic contaminants listed above, they do not easily absorb through the skin and have a relatively low health risk unless ingested.

Potential properties of concern are shown in Figure 5. Based on the environmental review, historical review, and the site reconnaissance, the potential for impact from contaminants to the improvement of the sewer system appears to be **low to moderate** within the Bellevue project area, as summarized in Table 4.

We recommend that construction monitoring be performed in areas of low risk, such as where USTs and/or fill material are suspected. If contamination is identified, it would then be necessary to provide appropriate health and safety measures to protect site workers and to analyze the soil for proper disposal. Hazardous household materials such as cleaners, paints, and solvents are often disposed of in the sanitary sewer system from residences and businesses such as paint shops, printers, and photo developers. These materials could leak into the soil through

sewer line joints. Also, sediments should be removed from manholes prior to work within the manhole to reduce the risk of exposure to hazardous materials for site workers.

TABLE 4
BELLEVUE PROPERTIES OF CONCERN

Property	Location	Contaminant Potential	Contaminant(s) of Concern
BEL011			
Residence with heating oil	4522 154th Place SE	Low	Petroleum products
BEL012			
Residences with heating oil	Various (Figure 5)	Low	Petroleum products
Hotel	15805 SE 37th Street	Low	Petroleum products
Washington Environmental Pro T	4017 162nd Avenue SE	Low	Unknown
Comcast Cable Communications Bellevue	3622 156th Avenue SE	Low	Unknown
Arrow Lumber	16343 SE 40th Street	Low	Petroleum products
76 Gasoline Station/ Tosco Corporation Site 2564273	15220 SE 37th Street	Low	Petroleum products
Schuck's Auto Supply	15303 SE 37th Street	Low	Petroleum products
Hewlett-Packard Company	15815 SE 37th Street	Moderate	Petroleum products, metals
Eastgate Plaza Custom Cleaner	15220 SE 38th Place	Moderate	Solvents
BEL031			
Residences with heating oil	Various (Figure 5)	Low	Petroleum products
5101 145th Place SE	5101 145th Place SE	Low	Petroleum products
Theil Collins Residence	5215 146th Avenue SE	Low	Petroleum products
BEL032			
Residences with heating oil	Various (Figure 5)	Low	Petroleum products
SPU Eastside Reservoir	4404 146th Avenue SE	Low	Unknown
South Bellevue Community Center	14509 SE Newport Way	Low	Petroleum products

Based on the potential health risks associated with contaminated soil and groundwater, we recommend that earthwork be avoided in the vicinity of the Hewlett-Packard Company site and the Eastgate Plaza Custom Cleaner site. If earthwork cannot be avoided, we recommend that

a Phase II Environmental Site Assessment be performed prior to earthwork activities to determine if contamination is present, and to analyze the soil and/or groundwater for health and safety measures and proper disposal. Because these two listed properties are not expected to be acquired by King County, the Phase II explorations should be confined to soil and/or groundwater sampling in the sewer line easement adjacent to the sites. Sampling could be conducted with a Geoprobe® at intervals to the approximate depth of the sewer line. Soil samples should be analyzed for petroleum products and metals in the vicinity of the Hewlett-Packard Company site and solvents in the vicinity of the Eastgate Plaza Custom Cleaner site.

2.2 Wetlands, Streams, and Wildlife Review

2.2.1 Document Review

WDFW Priority Habitats and Species Map. Three priority habitats were mapped in the north portion of mini-basin BEL032. Two of these priority habitats, associated with Eastgate Park, are designated as urban natural open space. The third priority habitat, containing two steep, wooded, riparian ravines that extend south from Eastgate Park, is designated as a riparian zone.

No priority species were mapped in the project area.

DNR Natural Heritage Information System Database. No records for rare plant or high quality ecosystems were identified in the project area.

DNR Forest Practices Application Review System. Four streams are mapped in the project area. Sunset Creek (mini-basin BEL032) and Vasa Creek (in min-basin BEL012, and also known as Squibbs Creek) are mapped as type F (fish-bearing) waters. A tributary to Vasa Creek (mini-basins BEL011 and BEL012) and an unnamed stream (mini-basin BEL012) in the eastern project area are mapped as type N (non-fish-bearing) waters.

King County Critical Areas Map. Four unclassified streams are mapped in the project area: Sunset Creek (mini-basin BEL032), Vasa Creek (mini-basin BEL012), the east tributary to Vasa Creek (mini-basins BEL011 and BEL012), and an unnamed stream (mini-basin BEL012) that crosses SE 43rd Street southeast of 164th Way SE. Vasa Creek and the unnamed stream are tributaries to Lake Sammamish. Sunset Creek flows north to Richards Creek. North of the project area and downstream of I-90, Vasa Creek and Sunset Creek are mapped as Class 2

Salmonid streams. No wetlands are mapped in the project area. No portion of the King County Wildlife Network is mapped in the project area.

King County Soil Survey. Soils in the project area are mapped in the King County Soil Survey as Alderwood gravelly sandy loam, beausite gravelly sandy loam, Everett gravelly sandy loam, Everett-Alderwood gravelly sandy loams, "Alderwood and Kitsap soils, very steep," "Arents, Alderwood material," "Arents, Everett material," and "Pits." None of these soil series is considered hydric.

2.2.2 Site Reconnaissance

A visual reconnaissance of the project area was conducted on March 3 and 4, 2008. The site is predominantly comprised of single-family homes, although some commercial properties are located along SE 37th Street.

Four streams were observed in the project area: Vasa Creek (mini-basin BEL012), the east tributary of Vasa Creek (mini-basins BEL011 and BEL012), Sunset Creek (mini-basin BEL032), and an unnamed stream (mini-basin BEL012). The unnamed stream is located in the eastern portion of the project area and crosses SE 43rd Street southeast of 164th Way SE. These streams are identified as Stream 1 (Vasa Creek), Stream 2 (unnamed stream), Stream 3 (eastern tributary of Vasa Creek), and Stream 4 (Sunset Creek) in Figure 6.

Six wetlands, identified as wetlands A, B, C, D, E, and F, were observed in the project area. Wetlands A, B, and D are located in mini-basin BEL012. The remaining wetlands are located in mini-basins BEL011 (Wetland C), BEL031 (Wetlands E and F), and BEL032 (Wetland F). Wetlands A, B, and C are forested/scrub/shrub riparian systems associated with site streams. Wetlands D, E, and F are palustrine forested/scrub/shrub systems. Wetland F is likely a stormwater detention pond and may not be subject to wetland regulations.

The urban, natural, open-space priority habitats mapped by WDFW and associated with Eastgate Park were observed to include steep forested slopes, a public utility facility, and South Bellevue Community Center. The riparian-corridor priority habitat mapped by WDFW was observed to include a steep, riparian ravine conveying Sunset Creek located southeast of Eastgate Park and a steep, forested slope located southwest of Eastgate Park. No raptors, raptor nests, or other priority habitats were observed during the site reconnaissance.

2.2.3 Conclusions

Wetlands and Wildlife. Six wetlands were observed in the project area: Wetlands A, B, and D (mini-basin BEL012), Wetland C (mini-basin BEL011), Wetland E (mini-basin BEL031), and Wetland F (mini-basins BEL031 and BEL032). See Figure 6 for wetland locations. Wetlands were not categorized, but general buffer requirements are discussed below. Both King County and the City of Bellevue wetland buffer width requirements depend on wetland classifications based on the adopted Washington State Wetland Rating System for Western Washington, Ecology Publication Number 04-06-025, published August 2004.

The City of Bellevue has jurisdiction over Wetlands A, B, C, and D. The Bellevue Municipal Code requires wetland buffer widths ranging from 40 to 225 feet, or as established through a previously approved and recorded Native Growth Protection Area (NGPA) or Native Growth Protection Easement (NGPE).

Wetlands E and F are located in unincorporated King County and are subject to King County's buffer requirements. Under King County code, Wetlands E and F would be subject to buffer widths ranging from 50 to 225 feet.

WDFW's PHS maps show three areas of priority habitat, designated as urban, natural, open-space and riparian zones. However, no priority species were indicated by our document review or observed during site reconnaissance in the project area. No areas were observed that would be regulated as habitats associated with species of local importance (under Land Use Code [LUC] 20.25H.150) or as a Wildlife Habitat Conservation area (under King County Code [KCC] 21A.24.382).

Streams. Four streams were observed in the project area: Vasa Creek (mini-basin BEL012), the east tributary to Vasa Creek (mini-basins BEL011 and BEL012), an unnamed stream (mini-basin BEL012), and Sunset Creek (mini-basin BEL032). All four site streams are likely regulated as type N waters by King County (KCC 21A.24.355) and/or the City of Bellevue (Bellevue LUC 20.25H.075). Type N waters are defined as all segments of aquatic areas, "that are not Type S or F waters and that are physically connected to Type S or F waters by an aboveground channel system, stream, or wetland." The site streams contain the following characteristics:

- They are not inventoried as "shorelines of the state" under Chapter 90.58 RCW.

- They are located upstream of legally constructed, human-made fish barriers, primarily the I-90 corridor, and therefore do not contain fish or fish habitat.
- They are streams that flow into type S waters (Lake Sammamish) or type F waters (lower Vasa Creek and lower Sunset Creek).

Within the project area, Vasa Creek, the east tributary to Vasa Creek, and Sunset Creek fall under the City of Bellevue's jurisdiction. For Type N waters, the City of Bellevue code requires a 50-foot buffer on undeveloped sites (i.e., sites that do not contain a primary structure). For developed sites (i.e., sites with an existing primary structure), the City of Bellevue code requires a 25-foot buffer or a buffer width as established with the existing NGPA or NGPE, whichever is greater.

The unnamed stream that crosses SE 43rd Street is located in unincorporated King County and is subject to King County's buffer requirements. King County's buffer requirements will need to be met for all site streams within King County. KCC requires a 65-foot buffer for Type N waters. The classifications and buffer widths for the site streams are summarized in Table 5.

TABLE 5
BELLEVUE AND KING COUNTY STREAM CLASSIFICATIONS AND BUFFER WIDTHS

Stream	Mini-Basin	City of Bellevue		King County	
		Classification	Buffer Width	Classification	Buffer Width
Vasa Creek	BEL012	N	25-50 feet	n/a	n/a
Vasa Creek – east tributary	BEL011, BEL012	N	25-50 feet	n/a	n/a
Sunset Creek	BEL032	N	25-50 feet	n/a	n/a
Unnamed stream	BEL012	n/a	n/a	N	65 feet

N = Type N water
n/a = not applicable

2.3 Landslide and Erosion Research

2.3.1 Geologic Conditions

Nearly the entire Bellevue project area is situated on the north-facing slope of the Newcastle Hills near the southwestern corner of Lake Sammamish. This north-facing slope consists of several ridges separated by three prominent, steep-sided, north-oriented drainages. In general, slopes on the ridges range from 15 to 50 percent while the slopes within the ravines range from 45 percent to steeper than 110 percent.

The Bellevue project area is underlain by Pleistocene glacial soils and Tertiary bedrock according to published geologic maps (Booth et al., 2006a; and Liesch, 1963). The primary surface deposit in the project area is Vashon Till, a very dense, gray, gravelly silty sand of glacial origin that is commonly referred to as "hardpan." East and west of the study area, and in the upper elevations to the south, bedrock of the Tukwila Formation forms the topographically high knobs and steep slopes. The Tukwila Formation is composed of silty sandstone and sandy siltstone with interbeds of andesitic lava flows (Walsh, 1984). Bedrock of the Tukwila Formation may also underlie Vashon till at shallow depths where the two units are mapped in close proximity to each other. Vashon glacial recessional deposits, consisting of normally consolidated, stratified sand and gravel with variable amounts of interbedded fine-grained silt and clay, exist along the lower portions of the project area. The Vashon recessional deposits range in density from loose to dense and/or very soft to stiff. Many of the steep slopes within the project area have been modified by residential housing construction, street grading, and park development.

The following sections describe the observations made during reconnaissance of each of the Bellevue mini-basins.

Mini-basin BEL012. An area of very steep slopes exist within the Vasa Creek ravine along the northwestern margin of SE Newport Way and extending north to the I-90 ROW. Evidence of soil creep in the form of bowed trees and shallow, colluvial slope instability related to creek erosion exist on the 80 to 100 percent slopes adjacent to the creek.

North of SE 43rd Street and east of 164th Way SE, slopes inclined from 80 to 100 percent and exhibited shallow soil creep and minor shallow colluvial instability adjacent to a northwest-flowing creek. Similar slope conditions exist downstream along the creek toward I-90.

South of SE 43rd Street, seepage, wet ground, and hummocky topography exist along the 70 to 100 percent slope. An older, 30-foot-wide, approximately 10-foot-deep slump and several vegetated gullies (one with silt fencing at the mouth) exist along the slope. Some bowed trees were also observed on this slope.

Slopes inclined 15 to 50 percent with seepage west of 160th Avenue SE; however, because the slope is densely developed, no observed instability was noted in the field.

Mini-basin BEL011. The most significant slope within mini-basin BEL011 is located west of 158th Avenue SE. The east-facing slope is inclined from 35 to 40 percent and exhibits abundant seepage issuing from the lower portions of the slope. Hummocky topography and possible tension cracks were observed midslope, just above the area of abundant seepage and wet ground. Soil erosion in the form of small, 1-foot-deep and 6- to 12-inch-wide, anastomosing gullies exist throughout the upper portions of the slope. Based on the abundant amount of sandstone clasts within the colluvium, the erosion appears to be confined to the colluvial layer formed on top of bedrock. Seepage was also observed issuing along the western curb of 158th Avenue SE.

Similar instability and seepage conditions were observed along the north-facing slope located south of SE 50th Street, particularly toward the eastern boundary of the mini-basin near 159th Place SE where the slope transitions from a convex to concave profile.

Mini-basin BEL031. Slopes inclined from 35 to 50 percent, with bedrock exposures west of Highland Drive near SE 49th Place. Minor seepage was noted based on the presence of wet bedrock outcrops along this slope. No instability was observed.

A relatively short, west trending ravine with 70 percent slopes exists west of 145th Avenue SE. Minor, shallow, colluvial sloughing was observed at the toe of the steep slopes. South of the ravine, toward the 145th Avenue SE dead end, the west-facing slope is generally inclined at 30 percent and exhibits no instability. Sandstone bedrock crops out along the 145th Avenue SE cut slope in this area. Abundant, potentially unstable yard waste has been placed on the roadway fill slope west of the 145th Avenue SE cul-de-sac.

Mini-basin BEL032. Slopes inclined from 55 to 65 percent in the vicinity of Eastgate Park and the adjacent SPU property at the northern end of the mini-basin. Little to no seepage was observed. A steep-sided ravine with slope inclinations in excess of 100 percent extends

along the eastern side of the SPU property. Stream bank erosion and related shallow colluvial instability exist along the steep ravine slopes. Instability in the form of an older, vegetated slump with an over-steepened toe along the creek was observed west of the 148th Avenue SE and SE 45th Place intersection.

The 50 to 60 percent slope located between 145th and 144th Avenues SE exhibited little to no seepage or signs of instability.

2.3.2 Presence or Proximity to Mapped Geologic Hazards

Based on the City of Bellevue and King County Critical Areas Maps, landslide hazard areas are mapped:

- Between SE Newport Way and SE 44th Place (BEL012)
- Between SE 43rd Place and SE 44th Place (BEL012)
- East of 158th Place SE (BEL012)
- West of 158th Avenue SE (BEL011)
- South of SE 50th Street (BEL011)
- East of the SE 46th Way and 159th Avenue SE intersection (BEL011)

No landslide hazard areas were mapped within mini-basins BEL031 and BEL032.

Erosion hazard areas are regulated by only King County and are generally confined to the Vasa Creek ravine and the northeast-trending ravine to the east in mini-basin BEL012. Additionally, portions of the area underlain by Vashon recessional soils in the Eastgate Park area (mini-basin BEL032) are also classified as an erosion hazard area. No erosion hazard areas are mapped within mini-basins BEL031 and BEL011.

With the exception of the instability observed west of 148th Avenue SE (mini-basin BEL032) and within the short, west-trending ravine west of 145th Avenue SE (mini-BEL031), the mapped erosion and landslide hazard areas are generally consistent with the field observations. However, steep slope hazard areas, consisting of slopes of 40 percent or greater, are not mapped and are ubiquitous throughout the Bellevue project area.

No coal mine or seismic hazard areas are indicated on the King County or City of Bellevue maps within the Bellevue project area.

2.3.3 Conclusions

The potential for inducing landsliding or erosion in most of the Bellevue project area is **low** to negligible; however, in some areas discussed above, listed below, and shown on Figure 7 the potential is moderate to high, if inflow or infiltration is currently being directed into sewer lines in these zones:

- The north-facing slope located south of SE 43rd Street (easternmost portion of mini-basin BEL012, **Area 1**)
- The east-facing slope located west of 158th Avenue SE (mini-basin BEL011, **Area 2**)
- The north-facing slope located south of SE 50th Street (southern portion of mini-basin BEL011, **Area 3**)
- The steep (70 percent) fill slope overlain by yard waste at the 145th Avenue SE cul-de-sac (mini-basin BEL031, **Area 4**)

Improvements to reduce I&I could cause the groundwater levels to rise, thereby increasing the risk of landslides. While we understand that the pipe-bursting method proposed for this project greatly reduces the amount of ground disturbance relative to trenching, the ground surface around maintenance holes located in steep, undeveloped ROW could be disturbed and may engender erosion in the erosion hazard areas, if BMPs are not followed during construction.

Based on our review of the maps, we understand that all of the utility components included in this project area lie within the City of Bellevue or unincorporated King County. Therefore, City of Bellevue and/or King County development standards apply to the planned improvements.

Both the Bellevue and King County Critical Areas Ordinances require a 50-foot setback from steep slopes (greater than 40 percent) or from all edges of identified landslide hazard areas. Exemptions from the setback requirement may be granted if studies by a licensed geologist or geotechnical engineer indicate that the landslide hazard could be mitigated or eliminated. On the other hand, both ordinances allow an exemption for normal and routine maintenance or repair of existing utility structures, if performed in compliance with permitting requirements. King County code allows clearing in erosion hazard areas only from April 1 through October 1, except under special provisions, which could include normal and routine maintenance or repair of existing utility structures.

2.4 Groundwater Systems Research

2.4.1 Groundwater Setting

The use and protection of groundwater in the Bellevue project area is governed by several local agencies. Drinking water is managed by the Cascade Water Alliance. Between mini-basins BEL031 and BEL011, an approximately 1,000-foot-diameter circle of the area near the intersection of SE 50th Street and 151st Street SE is located in a wellhead protection area (King County, 2007). The Bellevue project area is not in a critical aquifer recharge area as identified by King County (King County, 2007) and is not located in a King County water management area (DNR, 1998).

2.4.2 Physiographic Setting

The project area consists of two north-south-trending sections. The section to the west is bordered by 143rd Avenue SE to the west, 147th Place SE to the east, and Eastgate Park to the north and is composed of mini-basins BEL032 and BEL031. The eastern section is bordered by SE 37th Street to the north, 168th Avenue SE to the east, and 154th Place SE to the west and is composed of mini-basins BEL012 and BEL011. The southern border for the project area is SE 50th Street. Elevations rise to the south, going from elevation 320 feet in the north up to elevation 1,150 feet in the south. Gullies and ravines are frequent, generally trending north-south along with the rise in elevation. Ravines are discussed in detail in the Geologic Conditions section (2.3.1) of this report.

The area sits on Vashon recessional outwash deposits at the lower elevations in mini-basin BEL012, and all mini-basins sit on Vashon Glacial Till toward the southern higher elevations (Booth et al., 2006a). Outside the project area, to the east, west, and south of the project area, the geology is mapped as areas of Tukwila Formation, silty sandstone to sandy siltstone (Walsh, 1984). Some of the mini-basin slopes are composed of colluvium made up of bedrock materials. The Tukwila Formation bedrock is likely to underlie the Vashon Till deposits; siltstone and sandstone underlying glacial till were found in well logs from the northeastern section of the project area (Liesch, 1955). Additional discussion can be found in the Geologic Conditions section (2.3.1).

Streams and wetlands were found in the project area, flowing downhill, generally to the north. Additional information can be found in the Wetlands, Streams, and Wildlife Review section (Section 2.2).

2.4.3 Site Reconnaissance

A visual drive-by reconnaissance was performed on March 18, 2008. The mini-basins are composed of single-family homes with small to large yards, depending on location. A trail system and small parks run through parts of the neighborhood. In mini-basin BEL012, SE 37th Street is populated with commercial buildings and parking areas.

Many of the residences have drains from their property through the sidewalk that discharge into the street. The drains are most frequent in mini-basins BEL032 and BEL031, but can also be found in all mini-basins. Some of these drains direct up to approximately 1 gallon per minute of groundwater off of the subject properties into storm drains. These drains are an indication of shallow groundwater, as well as groundwater inflow into the sewer system.

Seeps were found frequently throughout the project area, particularly at the bases of slopes in mini-basin BEL011 (Figure 8). Seeps were generally located in mini-basins BEL032 and BEL031 at SE 46th Street, SE 49th Place, 145th Avenue SE, 145th Place SE, 146th Avenue SE, Sommerset Boulevard and Highland Drive. Seeps in mini-basin BEL011 are generally located on SE 43rd Street, SE 49th Street, SE 50th Street, and 158th Avenue SE. Additional small seeps could be found in all four mini-basins in weeping rockeries or as water coming out of landscaping, or cracks in pavement at various residences. The seeps are a likely indication of shallow or perched groundwater in the project area.

Potential stormwater retention or infiltration ponds were visible in both mini-basins BEL032 and BEL031, at the intersections of SE 46th Street and 145th Place SE, Highland Drive and 144th Place SE, SE Somerset Boulevard and 143rd Avenue SE, and the western side of 145th Place SE and SE 51st Street. In mini-basin BEL012, a stormwater retention/infiltration pond is located east of 164th Way SE and SE 43rd Street. These ponds may infiltrate water and impact shallow groundwater.

On SE 50th Street, in mini-basin BEL031, the area has open ditches with standing water. In mini-basin BEL012, open ditches and drainages are frequent north of SE 43rd Street and off of SE 44th Place. These ditches may infiltrate and impact shallow groundwater.

In mini-basin BEL012, a building that looks similar to a well pump house is located at 164th Way SE and SE 43rd Street, and a reservoir is located uphill off of 164th Way SE, just outside of the mini-basin. We did not find information on the pump house or the reservoir.

2.4.4 Groundwater Occurrence

In our opinion, the project area does not have a significant shallow groundwater table within the glacial till areas in the upland sections. Most of the seeps were found coming from areas of colluvium at steep slopes, with the water likely perching on less permeable bedrock or glacial till. Pockets of coarse-grained soils were found in the glacial till and could contribute to small amounts of groundwater. In the recessional outwash deposits in the northern part of mini-basin BEL012, significant shallow groundwater could be encountered.

We reviewed our project files for the Bellevue project area and found that to the north of the selected site, groundwater was found in borings ranging from 14 to 30 feet bgs during explorations for the Eastgate Park & Ride project (Shannon & Wilson, Inc., 2001).

From the GeoMaps NW search, we identified a report addressing 15642 SE Newport Way, in mini-basin BEL012, which encountered perched water at 4 feet bgs in one test pit, and noted groundwater seepage near Vasa Creek (Associated Earth Sciences, 1992).

2.4.5 Ecology Well Logs

Well records and drilling logs were collected from Ecology for the Bellevue project area and immediate surrounding areas. Specific areas included township 24 North, Range 4 East, Section 11 and township 24 North, Range 5 East, Sections 13, 14, 15, 22 and 23. Well logs provide depth-to-water information for Table 6 in the following section.

2.4.6 Depth to Water

The depth to groundwater generally depends on the presence of perching layers in relation to the ground surface in the upland areas, and the presence of surface water bodies in the lowland areas.

2.4.7 Water-level Fluctuations

No specific water-level fluctuation data were identified. Based on experience in similar locations, we assume that groundwater in recessional outwash could fluctuate seasonally in relation to surface water features and rainfall. Also, groundwater may perch on top of the glacial till. In our opinion, the amount of perched water likely would fluctuate seasonally, with less water present during the summer and fall and more water present during the winter and spring or following prolonged rainfall events.

TABLE 6
GROUNDWATER DEPTHS – BELLEVUE PROJECT AREA

Township, Range, Section	Address	Depth to Water	Date
24, 5E, 23 (between mini-basins BEL031 and BEL011)	15109 SE 53rd Place	125	July 1960
24, 5E, 14	4538 160th Place SE	8, 9	February 2004
24, 5E, 14 (east)	16300 SE 45th Street	2	August 1999
24, 5E, 11	(Not indicated)	142	January 1964
24, 5E, 11	(Not indicated)	6	March 1945
24, 4E, 11	15815 SE 37th Street	15, 24	February 2000
24, 5E, 14 (east)	4603 164th Avenue SE	2	July 2002
24, 5E, 14 (east)	16316 SE 45th Street	173	July 2000
24, 5E, 11 (north)	15220 SE 36th Place	30, 31, 32	November 2004
24, 5E, 11 (north)	3670 150th Avenue SE	36, 38, 39	November 2004
24, 5E, 11 (north)	150th Avenue SE HOV Access to I-90	10, 11, 12, 14	2004
(west)	4450 142nd Avenue SE	18	July 1982

Notes: The depth to groundwater in the project area was identified from Washington State Department of Ecology Well Records.
HOV = high-occupancy vehicle
I-90 = Interstate 90

2.4.8 Groundwater Flow Direction

In general, shallow groundwater follows the surface topography, flowing to the north, following the downslope, toward Lake Sammamish and Lake Washington. Locally, the direction of groundwater flow may be influenced by variability in soil conditions, the presence of surface water, and subsurface structures, including utility trenches.

2.4.9 Conclusions

With respect to sewer infiltration, significant volumes of groundwater may be found in mini-basin BEL012 in the vicinity of sewer lines and manholes along the northern part of the project area in the recessional outwash deposits. Excavation activities in these sand and gravel areas may require construction dewatering to control groundwater inflow that could affect test pits associated with pipe-bursting activities. Pipe-bursting activity could cause groundwater pressures to rise around the bursting head, making the saturated soils more fluid. In this area,

construction methods used in pipe bursting should control soil brought by groundwater inflow between the burst and replacement pipes, to prevent locking of the pipes during installation.

In our opinion, seeps generally demonstrate shallow groundwater accumulating in colluvial deposits, likely contributing to sewer infiltration, and may pose problems during excavation activities. Construction dewatering activity could be necessary in the vicinity of test pits, and construction methods should also control soil and groundwater inflow between pipes during construction.

Lesser accumulations of groundwater could perch atop glacial till or exist within coarse-grained lenses in the till. Groundwater in glacial till areas could contribute to sewer infiltration but likely does not pose significant problems during excavation activities, and only limited construction dewatering could be necessary.

Mini-basins BEL031, BEL032, and BEL012 have potential stormwater infiltration or retention areas. Through infiltration, there is a potential for increased groundwater in these areas, which could result in a need for limited construction dewatering. In mini-basins BEL031 and BEL012, the area has open ditches with standing water. This standing water indicates that the area has a high groundwater table, which could result in a need for limited construction dewatering.

The presence of a wellhead protection area between mini-basins BEL031 and BEL011 may require coordination with regulatory agencies for the proposed project. The King County Department of Health is responsible for the wellhead protection area. Notification prior to work in the area is recommended and the use of BMPs may be required to protect groundwater resources.

3.0 SKYWAY PROJECT AREA (MINI-BASINS BLS001, BLS002, AND BLS003)

3.1 Hazardous Materials Research

3.1.1 Site Description

The Skyway project area is located on an upland plateau located west of Lake Washington. Land use within the project area is predominantly residential.

The study was conducted to evaluate if hazardous materials could be encountered during the proposed sewer upgrade project. The identified properties were ranked **low, moderate**, or **high** based on the likelihood of contaminants to be present in the soil in the vicinity of the sewer line and manholes where excavation could occur. Properties with known groundwater and/or soil contamination located near or adjacent to the sewer are considered to have a **high** potential to contaminate the soil in the vicinity of the sewer line. Adjacent businesses such as historical gas stations, historical automobile repair shops, dry cleaners, print shops, paint shops and photo shops, where there are no known releases, are considered to have a **moderate** potential to contaminate the soil. These types of businesses have commonly released contaminants into the soil and/or groundwater; however, where no evidence of a release has been observed or documented, the risk of contamination is considered to have a **moderate** potential to impact the project area. Properties adjacent to sewer lines where reported petroleum or chemical spills of significant or unreported size have reached the soil are also considered to have a **moderate** potential to impact the project area.

Businesses, including gas stations and automobile repair shops developed since approximately 1988, construction companies with no known USTs, and residences with heating oil tanks are considered to have a **low** potential to impact the project area. Newer gas stations are considered to have a **low** contamination potential because of the implementation of stringent regulations for UST construction, system installation, monitoring and testing. Although construction companies frequently have USTs, such companies are considered to pose a **low** potential for contamination where the presence of USTs has not been confirmed. Properties with heating oil tanks are considered to have a **low** potential because heating oil generally does not travel far in soil. The locations of the identified properties having a potential to impact soil in the vicinity of the sewer line are indicated in Figure 7.

3.1.2 Document Review

Local, State, and Federal Environmental Databases. EDR was subcontracted to conduct a search of available agency databases for sites within distances recommended by ASTM for Phase 1 Environmental Site Assessments. The search included EPA, Ecology, Tribal, and local databases for known and suspected contaminated sites.

Seven properties within the project area and one CERCLIS-NFRAP site within one mile of the project area boundary were identified. The seven identified properties were on one or more of the following databases: Spills, LUST, UST, ICR, FINDS, and Emergency Response

Notification System (ERNS). The CERCLIS-NFRAP site (Boeing Renton) was also on the CSCSL, RCRA-Large Quantity Generator, Toxic Chemical Release Inventory System, RCRA-Treatment, Storage, and Disposal Facility, RCRA Administrative Action Tracking System, RCRA Corrective Action, Hazardous waste manifest data, ICR, Engineering Controls Sites, and Sites with Institutional Controls lists.

These listed sites are shown in Figure 9 and are summarized below.

- **10814-10822 Rainier Avenue South, Seattle (Spills, ERNS) –** Diesel fuel was reportedly spilled into surface water (Lake Washington) in March 2002. The quantity is identified as a 5 x 200-foot sheen. Because the site is listed as a one-time spill into the lake, and the site is not on other databases that would indicate that contamination is present, this property is not considered a risk to impact the project area.
- **10920 Rainier Avenue South, Renton (Spills) –** An unknown chemical was reportedly spilled into surface water in April 2003. Based on the location of the property, the surface water was likely Lake Washington. Because the site is listed as a one-time spill into the lake, and the site is not on other databases that would indicate that contamination is present, this property is not considered a risk to impact the project area.
- **8528 South 121st, Renton (Spills)** – An unknown chemical was reportedly spilled inside a building in April 2001. Because the site is listed as a one-time spill, there is no indication that the spilled material reached soil, and the site is not on other databases that would indicate that contamination is present, this property is considered to have a **low** potential to impact the soil in the vicinity of the manholes.
- **Former Lake Washington Greenhouses, Inc., 12167 87th Avenue South, Seattle (LUST, UST, ICR, FINDS)** – Two USTs were removed from the site and three additional USTs have unknown status (two leaded gasoline USTs; and one unleaded gasoline UST). The LUST and ICR databases indicate that petroleum-impacted soil was cleaned up in 1998. This site is considered to have **low** risk to impact the project area because remediation activities have occurred on the site, and because it is located at least 500 feet from the nearest BLS003 mini-basin sewer line.
- **Renton Facilities and Operation Center/Site SE 11 Renton, 12607 82nd Avenue South, Renton (UST, FINDS)** – One small UST (between 111 and 1,100 gallons) was removed from the property (stored substance not indicated). The database indicates that the UST was installed in 1985. No known contamination was identified. Because no contamination was identified, the site is considered to have a **low** potential to impact the soil excavation areas.
- **King County Fire District 20, 11619 84th Avenue South, Seattle (UST, FINDS)** – A waste oil UST was closed in place (capacity between 111 and 1,100 gallons). The site is within the project area, but not adjacent to the sewer line. Based on the site's no known

contamination status and its location relative to the project, the site is considered to have **low** potential for impacting soil excavation areas.

- **South 120th Street and 79th Avenue South, Skyway (ERNS)** – A pole-mounted transformer fell and approximately 20 gallons of oil spilled in October 1997. Cleanup response included sweeping oil off of the street and out of a catch basin. Because the site is listed as a one-time spill, there is no indication that spilled oil reached soil, and the site is not on other databases that would indicate that contamination is present, this site is considered to have a **low** potential to impact soil in the vicinity of manholes.
- **11440 82nd Place South, Seattle (ERNS)** – Reportedly, product from a 200-gallon UST spilled in the yard in December 1995, and soil smelled of petroleum. The issue was referred to Ecology. The site is located adjacent to a sewer line, and because soil was reportedly impacted, it is considered to have a **moderate** potential to impact the project area.
- **Bryn Mawr Lakeridge Water & Sewer District, 7843 South 116th Street, Seattle (FINDS)** – Ecology's database indicates that the site has an active listing in the Hazwaste program. Facilities that store hazardous chemicals report annually for emergency preparedness planning. Inclusion on this database does not indicate that a release of hazardous materials has occurred. Therefore, this site is considered to have a **low** potential to impact soil in planned excavation areas.

The Boeing Renton aircraft manufacturing site (800 North 6th Street) is located approximately 0.8 mile east of the closest project boundary. The database information indicates that groundwater is known to have been impacted by petroleum products, phenolic compounds, non-halogenated solvents, priority pollutant metals/cyanide, other metals, PCBs, and conventional inorganic contaminants. Other contaminants are suspected. Remedial action is in progress. Based on the site's distance and the fact that the Cedar River is between the Boeing site and the project area, this property is not considered a risk to the project.

All other sites listed outside of the project area were not considered a potential environmental concern because of the type of database listing and/or relative distance from the project area.

Cole's and Polk City Directories. City directories were reviewed at the Seattle Public Library for the years 1971-1972, 1977, 1981-1982, 1986-1987, 1991-1992, 1997, 2002 and 2007. A Polk City Directory was reviewed for 1967.

The listings were predominantly residential, although some of the residential addresses were listed as home businesses. Home businesses of potential environmental concern include construction/contractor, landscaping, roofing, taxidermy, handyman and painting. In 1997,

10820 Lake Ridge Drive South was listed as Standard Natural Gas. Between 1991 and 2002, 10441 Dixon Drive South was listed as Accident Reconstruction, which could have potentially been an auto body shop associated with the home address. Perovich & Son fuel was listed at 12433 84th Avenue South in 1981/82 and 1977, and potentially could have been a small gas station or a fuel distributor. Based on the limited time duration of the listed businesses, database search for USTs, and visual observations of the properties during our site reconnaissance, it is unlikely that subsurface soils are contaminated above regulatory cleanup levels associated with these properties. However, the Perovich & Son property is still considered to have a **low** potential to impact soil in the vicinity of manholes because of the potential for a former fueling station.

Sanborn Fire Insurance Maps. Sanborn Fire Insurance Maps were not available for the project area.

King County Assessor Records. Current tax assessor records were reviewed online at the King County iMap website. Tax assessor information prior to 1970 for this project was reviewed at the Puget Sound Regional Archives. Most of the parcels in the project area were residential, with 55 currently or historically using heating oil (Figure 9). Heating oil generally has low mobility when it has been released to subsurface soils. As a result, contamination is usually not widespread.

One property of concern, the Former Lake Washington Greenhouses, Inc., was identified during our assessor record research. The assessor records indicate that the former Lake Washington Greenhouses referenced in the previous section included multiple parcels covering most of the property between South 121st Street and South 123rd Place, and between 85th and 87th Avenues South. Based on the windshield survey, most of the land has been redeveloped as residential properties. The historical greenhouse operations, in addition to the use of petroleum products, may have involved the use of pesticides and herbicides. However, this site is considered to have **low** risk to the project because it is located at least 500 feet from the nearest sewer line.

3.1.3 Site Reconnaissance

A visual reconnaissance of the project area was conducted on March 3 and June 30, 2008. In general, the project area is predominantly comprised of single-family homes. No properties of concern were identified during our site visit.

3.1.4 Conclusions

The potential for impact to the sewer line from contaminated sites was evaluated based on the type of business, the proximity of the parcel to the sewer line, and the known or suspected presence of contaminants. In areas where the water table is at or above the sewer pipe elevation, the sewer trench backfill could be serving as a hydraulic conduit for contaminated groundwater migration. In such cases, it is possible that groundwater could carry contamination for considerable distances downgradient along the sewer line corridor. In addition, excavation and dewatering practices used during sewer line repair activities could create or modify contaminant migration pathways and/or distribution. However, this is unlikely because of the limited excavation and dewatering that is anticipated for this project.

The toxicity and cost of remediating contaminated soil that could be encountered during sewer line improvements vary depending on the type of contaminant. For example, dry cleaning solvents are highly toxic at low concentrations, and remediation costs are typically very high. Other solvent contaminants resulting from businesses such as photo processing or printing shops may be less toxic than dry cleaning solvents, but they can also result in high remediation costs. Soils contaminated with gasoline-range petroleum hydrocarbons generally have a lower toxicity and a lower disposal cost than soils contaminated with solvents, depending on the age of the gasoline. A more recent gasoline spill has more benzene, its most toxic component. The more benzene present in the soil, the higher the remediation costs. Older gasoline tends to be less toxic and somewhat less expensive to remediate. Diesel- and oil-range petroleum hydrocarbons are the least toxic and least mobile petroleum contaminants and typically have the lowest cleanup costs. Metal contaminants could result in high remediation costs, but unlike the organic contaminants listed above, they do not easily absorb through the skin and have a relatively low health risk unless they are ingested.

Potential properties of concern are shown in Figure 9. Based on the environmental review, historical review, and the site reconnaissance, the potential for impact from contaminants to the improvement of the sewer system appears to be **low to moderate** within the Skyway project area, as summarized in Table 7.

TABLE 7
SKYWAY PROPERTIES OF CONCERN

Property	Location	Contaminant Potential	Contaminant(s) of Concern
BLS001			
Residences with heating oil	Various (Figure 9)	Low	Petroleum products
8528 South 121st Street	8528 South 121st Street	Low	Unknown
Renton Facilities and Operation Center/Site SE 11 Renton	12607 82nd Avenue South	Low	Unknown
Perovich & Son	12433 84th Avenue South	Low	Petroleum products
BLS002			
Residences with heating oil	Various (Figure 9)	Low	Petroleum products
BLS003			
Residences with heating oil	Various (Figure 9)	Low	Petroleum products
Former Lake Washington Greenhouses, Inc.	12167 87th Avenue South	Moderate	Petroleum products, lead, pesticides, herbicides
King County Fire District 20	11619 84th Avenue South	Low	Petroleum products
South 120th Street and 79th Avenue South	South 120th Street and 79th Avenue South	Low	PCBs
11440 82nd Place South	11440 82nd Place South	Moderate	Petroleum products
Bryn Mawr Lakeridge Water & Sewer District	7843 South 116th Street	Low	Unknown

PCB = polychlorinated biphenyls

We recommend that construction monitoring be performed in areas of **low** risk, such as where USTs and/or fill material are suspected to be present. If contamination is identified, it would then be necessary to provide appropriate health and safety measures to protect site workers and to analyze the soil for proper disposal. Hazardous household materials such as cleaners, paints, and solvents are often disposed of in the sanitary sewer system from residences and businesses such as paint shops, printers, and photo developers. These materials could leak

into the soil through sewer line joints. Also, sediments should be removed from manholes prior to work within the manhole to reduce the risk of exposure to hazardous materials for site workers.

Based on the potential health risks associated with contaminated soil and groundwater, we recommend that earthwork be avoided in the vicinity of the residence located at 11440 82nd Place South. If earthwork cannot be avoided, we recommend that a Phase II Environmental Site Assessment be performed prior to earthwork activities to determine if contamination is present, and to analyze the soil and/or groundwater for health and safety measures and proper disposal. Because the 11440 82nd Place South residence is not expected to be acquired by King County, the Phase II exploration should be confined to soil and/or groundwater sampling in the sewer line easement adjacent to the site. Sampling could be conducted with a Geoprobe® at intervals to the approximate depth of the sewer line. Soil samples should be analyzed for petroleum products.

3.2 Wetlands, Streams, and Wildlife Review

3.2.1 Document Review

Washington State Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) Map. Two priority habitats, designated as "Urban Natural Open Space," are mapped in the project area. These habitats are shown within mini-basin BLS002 and described as forested ravines with intermittent streams. Two bald eagle nest sites, identified in 2006, are mapped in or near the project area. Northern portions of the project area fall within the mapped bald eagle 800-foot and shoreline nest buffer. Lake Washington, adjacent to the project area, is reported to contain fall Chinook salmon, Coho salmon, bull trout/Dolly Varden, sockeye salmon, winter steelhead, and coastal cutthroat trout. These species are considered priority species by WDFW.

Washington State Department of Natural Resources Natural Heritage Information System Database. No records for rare plants or high quality ecosystems were identified in the project area.

Washington Department of Natural Resources Forest Practices Application Review System. Taylor Creek and an unnamed stream, identified as Stream 1, are mapped in or adjacent to the project area. Stream 1 crosses into mini-basin BLS002 near its southwestern boundary. Stream 1 is mapped as a Type N stream (for the upper 400 feet) and as a Type F stream. Taylor

Creek, located to the west of the project area, is mapped as a Type F stream. No wetlands were mapped in the project area.

King County Sensitive Areas Map. Three unclassified streams (Taylor Creek, Stream 1, and a tributary to Stream 1) are mapped in or adjacent to the project area. No wetlands were mapped in the project area. No portion of the King County Wildlife Network is mapped in the project area.

King County Shoreline Management Program Map. A narrow portion of the project area along Rainier Avenue South is mapped as shoreline jurisdiction and designated as urban shoreline environment.

King County Soil Survey. Current and historical soil survey data were reviewed for the project area. Soil survey data (published in 1952) maps Alderwood gravelly loam and Alderwood gravelly sandy loam over most of the project area with Cathcart loam in the southern portion of mini-basin BLS001 and "Rough broken and stony land" along the western portion of mini-basin BLS002. Current soil survey data is not available for areas west of 84th Avenue South. Current soil survey data maps areas east of 84th Avenue South as Alderwood gravelly sandy loam and Norma sandy loam. Norma sandy loam is considered to be hydric.

City of Seattle Department of Planning and Development Geographic Information System (GIS). While the majority of the project area is located in unincorporated King County, the western portion of mini-basin BLS002 is located within Seattle city limits. Several "environmentally critical areas" are mapped along the Seattle city boundary. A riparian corridor and wetland along a stream are shown along Taylor Creek at the western boundary of mini-basin BLS002. Wildlife areas are mapped along western and southwestern boundaries of mini-basin BLS002.

Seattle Public Utilities (SPU). Christopher May, stormwater and urban stream habitat lead, provided information on Taylor Creek through a telephone conversation on July 7, 2008. According to Mr. May, the culvert under Rainier Avenue South, located 100 to 200 feet from the creek's mouth, is a barrier to fish passage. Resident cutthroat trout are present in the stream above this culvert. Coho, sockeye, and cutthroat are present in the stream below this culvert. SPU plans to remove this fish barrier within the next couple of years.

Washington State Department of Fish and Wildlife (WDFW). Larry Fisher, area habitat biologist for the project area, provided information on Stream 1 through a telephone conversation on July 7, 2008. According to Mr. Fisher, Stream 1 does not contain fish or fish habitat.

3.2.2 Site Reconnaissance

A visual reconnaissance of the project area was conducted on March 3 and June 30, 2008. The project area included mini-basins BLS001, BLS002, and BLS003. The project area is comprised of single-family homes and a few undeveloped lots. Bryn Mawr Park runs along the boundary between mini-basins BLS001 and BLS003. Lakeridge Park is located along the western boundary of mini-basin BLS002.

Taylor Creek and two unnamed streams, identified as Stream 1 and Stream 2, were observed in or near the project area (Figure 10). Taylor Creek and Stream 1 drain to Lake Washington. Taylor Creek was observed west of the project area in a forested ravine within Lakeridge Park. Stream 1 was observed north of South 114th Street and crosses into the project area at the southeastern boundary of mini-basin BLS002. South of South 114th Street, land has been recently graded and no stream was observed. The tributary to Stream 1, as mapped by the King County Sensitive Areas Map, corresponds to a ravine at the western boundary of BLS003 east of 76th Avenue South. No signs of flowing water or stream channel were observed in this ravine. Stream 2 is located in mini-basin BLS001 and flows northeast from 81st Place South to South 123rd Street where it enters a catch basin.

Three wetlands were observed in the project area. The first wetland was a scrub/shrub system observed within the ravine east of 76th Avenue South and south of South 116th Street. The second wetland was a small scrub/shrub system associated with Stream 2. The third wetland was a small forested/scrub/shrub system on a vacated segment of the South 123rd Street ROW and located immediately west of 85th Avenue South. A potential emergent wetland was observed approximately 250 feet from the project area near the Lake Washington greenhouses.

The urban natural open-space priority habitats mapped by WDFW were observed to include steep, forested ravines conveying Taylor Creek and Stream 1. A bald eagle nest was observed near the southeastern portion of mini-basin BLS002 at approximately South 112th Street and 84th Avenue South. No raptors were observed during reconnaissance. The WDFW

PHS map identified another bald eagle nest west of the project area. No nest was observed at this location.

3.2.3 Conclusions

Shoreline. A narrow portion of the project area along Rainier Avenue South is in King County's shoreline jurisdiction and designated as urban shoreline environment. The proposed activities appear to qualify as exempt from shoreline substantial development permit requirements under Washington Administrative Code (WAC) 173-27-040(2)(b), as they are "normal maintenance or repair of existing structures or developments." Shoreline exemptions can be approved by King County.

Wetlands. Three wetlands were observed in the project area. King County code requires wetland buffer widths ranging from 50 to 225 feet. Wetland buffer widths depend on a wetland classification based on the adopted Washington State Wetland Rating System for Western Washington.

Streams. Three streams were observed in or near the project area. King County's water typing system (KCC 21A.24.355) designates four water types: Type S, F, N, and O. Type S waters are defined as shoreline of the state. Type F waters includes streams that are not Type S waters and contain fish or fish habitat. Type N waters include streams that are not Type S or F waters and connect to Type S or F waters by an aboveground channel system. Type O waters include streams that are not Type S, F, or N waters and do not connect to these waters by an aboveground channel system.

Taylor Creek would likely be considered a Type F water, as it is known to contain cutthroat trout and is not a shoreline of the state. Stream 1 would likely be considered a Type N water, as it is reported to contain no fish or fish habitat and it connects to Lake Washington (a Type S water) by an aboveground channel system. Stream 2 would likely be considered a Type O water, as it does not contain fish or fish habitat and drains to a stormwater catch basin.

King County requires 25-foot buffers for type O streams, 65-foot buffers for Type N streams that are within the urban growth area, and 115-foot buffers for Type F streams that are within the urban growth area and not with a basin or shoreline designated as **high**, as is the case for the project area. According to King County's GIS stream data, Taylor Creek is located

approximately 60 feet west of the project area boundary. Although Taylor Creek is located outside of the project area, its associated buffer would likely overlap the project area.

Bald Eagle. A bald eagle nest was observed in or near the project area. Bald eagles are protected by the following county, state, and federal laws:

- *King County* – King County defines areas within 400 feet from an active bald eagle nest as wildlife habitat conservation areas (KCC 21A.24.382). Activities within 800 feet of the nest must comply with King County's Critical Areas regulations. If the nest is active (being used), construction activities would likely be restricted during parts of the year. Within 800 feet of an active nest, alterations are not allowed between March 15 and April 30, and land-clearing machinery such as bulldozers, graders or other heavy equipment, may not be operated between January 1 and August 31.
- *State* – For activities within ½ mile of a bald eagle nest, where WDFW determines that the proposed activity would adversely impact eagle habitat, a bald eagle management plan (BEMP) would be required. A BEMP is a habitat protection agreement that focuses on maintaining nest trees, perch trees, and associated screening trees.
- *Federal* – In July 2007, the bald eagle was removed from protection under the federal Endangered Species Act. However, two other federal laws still provide protection for the bald eagle, the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. These laws primarily address nest tree protection and protection from harassment. Federal laws and regulations come into play when a federal permit is required (such as a permit from the U.S. Army Corps of Engineers). If no federal permits are required for this project and no harm to eagles or their nests is anticipated, federal laws and regulations on protecting bald eagles may not apply to the proposed activities.

3.3 Landslide and Erosion Research

3.3.1 Geologic Conditions

The Skyway study area is located on an upland plateau that overlooks Lake Washington. The ground surface is gently sloping, from 0 to 20 percent. Steep slopes (greater than 40 percent) exist in and adjacent to the western and eastern portions of mini-basin BLS001, within the creek ravines at the north and south margins of BLS002, and within the Bryn Mawr Park area of mini-basin BLS003.

Published geologic maps for this area (Waldron et al., 1962; Mullineaux, 1965; and Booth et al., 2006a) indicate that Vashon Till, a very dense, gray, gravelly, silty sand of glacial origin, underlies most of the Skyway project area. Glacial recessional, normally consolidated soils are mapped on top of the till in several locations:

- Along the east-facing slopes above Rainier Avenue South, east of 85th Avenue South, between South 121st Street and NW 7th Street (BLS001) and at the mouth of Taylor Creek (BLS002).
- On the steep slopes along the western margin of BLS001 and in the vicinity of Bryn Mawr Park in (BLS003).

These normally consolidated, glacial, recessional deposits are generally composed of interbedded sand, gravel, silt and clay and commonly show signs of seepage and Holocene slope instability. These deposits have not been glacially overridden and are therefore less dense than the underlying till.

Older, pre-Vashon glacial and interglacial deposits underlying the Vashon Till are exposed along the steep valley walls of Taylor Creek.

Bedrock of the Tukwila Formation underlies the glacial soils in the project area. While previous mapping by Waldron (1962), Mullineaux (1965) and Booth (2006a) do not show bedrock at the ground surface, bedrock exposures were observed on the steep, east-facing slopes of the Bryn Mawr Park area in BLS003 and along the western margin of BLS001 during field reconnaissance.

Mini-basin BLS001. The dominant feature of mini-basin BLS001 is a large area of steep slopes (greater than 40 percent) in and adjacent to the western portion of the project area. Steep slopes also exist adjacent to the extreme eastern end of the project area immediately above Rainier Avenue South. The southwestern, central, and northeastern portions of the project area are relatively flat lying (slopes of 0 to 15 percent).

Dodds Geosciences, Inc. excavated three test pits at a site on South 123rd Place just east of 84th Avenue South in 1994. They encountered as much as 10.5 feet of fill material on top of glacial till, which is consistent with the mapped geology. During field reconnaissance, our geologists also observed exposures of till at several locations in the western portion of the project area.

While recently developed streets within the project area were built with curbs and storm drainage systems, most streets in the project area lack curbs, and stormwater runoff is directed into ditch inlets in the unpaved parking strips.

Groundwater seeps were observed at two locations: 8115 South 120th Street and 8201 South 121st Street. Standing water was observed in a gravel alley between South 120th and South 121st Streets at 82nd Avenue South. The seepage water is heavily iron-oxide stained and assumed to be issuing from bedrock fractures that daylight on the steep slopes along the western boundary of the project area. Surface water runoff from the Dimmitt Middle School parking lot appears to drain eastward down the school driveway and across 81st Place South. A ravine has been scoured into the steep slope between 81st Place South and 82nd Avenue South, presumably by water from the school and/or 81st Place South.

Throughout much of the project area, newer developments include retaining wall systems and rockeries with no observed signs of instability. However, slight soil creep and bent trees were noted at the head of a ravine on the eastern side of Lind Avenue NW just outside the eastern boundary of the project area. Pavement cracking in the driveway at 8217 South 123rd Place may indicate slope movement and/or fill settlement. An ecology-block wall failure was observed at 12117 82nd Avenue South, and slight cracking of an older concrete retaining wall was seen at 12323 85th Avenue South.

Mini-basin BLS002. Mini-basin BLS002 is located on an upland plateau that overlooks Lake Washington. Nearly the entire mini-basin is underlain by Vashon Till. The ground surface is gently sloping to the north and northwest, from 0 to 20 percent. Very steep (steeper than 70 percent) slope gradients exist within the Taylor Creek and Stream 1 drainages, at the western and eastern margins of the mini-basin, respectively. Other isolated areas of steep slopes exist along Rainier Avenue South and Dixon Drive South.

Observations made in the vicinity of Rustic Road South, north of South 108th Street, indicate possible surface water runoff and infiltration into properties adjacent to very steep slopes of the Taylor Creek ravine. Roadway cracking, wet ground, and seepage were also observed at the toe of the slope northeast of the Cornell Avenue South and Rustic Road South intersection.

Along Dixon Drive South, between South 106th Street and 76th Avenue South, 3- to 20-foot-high steep slopes exist (some are road cuts), but no signs of seepage or instability were observed. A depression with steep side slopes (60 to 80 percent) located at the "T" intersection of South 106th Street and Laurel Lane South appears to be the head of a former channel. The depression is covered in briers, and no instability was observed.

Observations along Rainier Avenue South (10800 block), downslope of Garden Place South, indicate moderately steep cut slopes approximately 3 to 12 feet high, with various types of retaining structures, including rockeries, concrete and wood walls, and earth buttresses. Abundant seepage and standing water exists along the slope toe adjacent to Rainier Avenue South, north of South Lakeridge Drive. Wet ditches were also observed along the Garden Place South cul de sac, upslope of the seepage observed along Rainier Avenue South.

Observations along the Stream 1 ravine at the southeastern corner of the mini-basin revealed 50 to 70 percent slopes with backtilted trees and hummocky topography, which are indicative of colluvial soil creep. Landslide debris associated with older slumps has deflected the creek channel in some reaches of this ravine.

Mini-basin BLS003. Approximately one-half of mini-basin BLS003 is relatively flat lying, ranging from about 0 to 15 percent. Bryn Mawr Park and an undeveloped lot between South 116th and South 118th Streets from 78th Avenue South to 80th Avenue South separate the eastern portion of the mini-basin from the topographically higher western portion, and a series of northeast-southwest-trending ravines cut through the park and wooded lot. The ravine slopes located east of 80th Avenue South, between South 123rd Street and South 122nd Street exhibit slope inclinations between 40 and 90 percent. The head of the Stream 1 ravine is located at about the intersection of South 114th Street and 80th Avenue South and flows northeast to Lake Washington, out of the mini-basin.

In general, reconnaissance of the mini-basin revealed little evidence of slope instability. However, bent trees and hummocky terrain were observed in the ravine east of 80th Avenue South at South 122nd Street where slopes range up to 90 percent.

3.3.2 Presence or Proximity to Geologic Hazards

Based on the City of Renton and King County Critical Areas Maps, landslide hazard areas are mapped as follows:

- Adjacent to Taylor Creek, west of Rustic Road South (BLS002)
- Upslope and downslope of Raymond Place NW (BLS001)
- East of 87th Avenue South along the slope adjacent to Rainier Avenue South (BLS001)

No landslide hazard areas are mapped within mini-basin BLS003.

Mapped erosion hazard areas are generally adjacent to and/or coincident with the landslide hazard areas in mini-basin BLS001. The erosion hazard areas correlate with mapped recessional glacial soils, and exist upslope of Raymond Place NW (BLS001) and east of 87th Avenue South along the slope adjacent to Rainier Avenue South (BLS001). No erosion hazard areas are mapped within mini-basins BLS002 or BLS003.

Areas of observed instability that are not currently mapped by local jurisdictions within geologically hazardous areas follow:

- The steep slope between South 123rd and South 124th Streets east of 81st Place South (BLS001)
- The steep slope between South 120th and South 122nd Streets west of 82nd Avenue South (BLS001)
- The ravine slopes along Stream 1 (BLS002)
- The east-facing slope below Garden Place South along Rainier Avenue South (BLS)
- The east-facing slopes located east of 80th Avenue South, between South 120th and South 123rd Streets (BLS003)

No coal mines or seismic hazard areas are indicated on the King County or City of Renton maps within the Skyway project area.

3.3.3 Conclusions

The potential for inducing landsliding or erosion in most of the Skyway project area is **low** to negligible; however, in some areas discussed previously and subsequently, and shown in Figure 11, the potential is **moderate to high**, if inflow or infiltration is currently being directed into sewer lines in these zones. These areas include:

- The slope above Rainier Avenue South east of South 121st and NW 7th Streets (easternmost portion of BLS001, **Area 1**)
- The slope east of 84th Avenue South in the vicinity of Raymond Place NW (BLS001, **Area 2**)
- The slope between South 123rd and South 124th Streets east of 81st Place South (eastern portion of BLS001, **Area 3**)
- The slopes located between South 120th and South 122nd Streets west of 82nd Avenue South (eastern portion of BLS001, **Area 4**)

- The east-facing slopes located east of 80th Avenue South, between South 120th and South 123rd Streets (BLS003, **Area 5**)
- The slopes north of South Sunnycrest Road, between Cornell Avenue South and Crestwood Drive South (BLS002, **Area 6**)
- The west-facing slope adjacent to the houses along Rustic Road South and Crestwood Drive South, between house nos. 10619 Rustic Road South and 11033 Crestwood Drive South (BLS002, **Area 7**)
- In the vicinity of the steep-sided depression, approximately 200 feet south and 200 feet north of house no. 10800 Forest Avenue South (BLS002, **Area 8**)
- The slope between Garden Place South and Rainier Avenue South, from South Lakeridge Drive, north to the Garden Place South cul-de-sac (BLS002, **Area 9**)
- The Stream 1 ravine slopes between 81st and 82nd Avenues South, and between Lotus Place South and 84th Avenue South (BLS002, **Area 10**)

Improvements to reduce I&I could cause the groundwater levels to rise, thereby increasing the risk of landslides. While we understand that the pipe-bursting method proposed for this project greatly reduces the amount of ground disturbance relative to trenching, the ground surface around maintenance holes located in steep, undeveloped ROW could be disturbed and may engender erosion in the erosion hazard areas, if BMPs are not followed during construction.

Based on our review of the maps, we understand that all of the utility components included in this project area lie within the City of Renton or unincorporated King County. Therefore, City of Renton and/or King County development standards apply to the planned improvements.

Both the Renton and King County Critical Areas Ordinances require a 50-foot setback from steep slopes (greater than 40 percent) or from all edges of identified landslide hazard areas. Exemptions from the setback requirement may be granted if studies by a licensed geologist or geotechnical engineer indicate that the landslide hazard could be mitigated or eliminated. On the other hand, both ordinances allow an exemption for normal and routine maintenance or repair of existing utility structures, if performed in compliance with permitting requirements. King County code allows clearing in erosion hazard areas from only April 1 through October 1, except under special provisions, which may include normal and routine maintenance or repair of existing utility structures.

3.4 Groundwater

3.4.1 Groundwater Setting

The Skyway project area is located north of the South King County groundwater management area (King County GPP, 2008). The southeastern end of mini-basin BLS002 is in a wellhead protection area, near the Oakwood Ave South and South Lakeridge Drive intersection. (King County GPP, 2008). Mini-basins BLS001 and BLS003 are in a wellhead protection area, centered around the community water source wells at 78th Ave South and South 116th Street (King County GPP, 2008). The Skyway project area is not in a critical aquifer recharge area as identified by King County (King County, 2004). The project area is not mapped as being susceptible to groundwater contamination (King County, 2008).

Drinking water is managed by the Cascade Water Alliance.

3.4.2 Physiographic Setting

Mini-basin BLS002 slopes northeastward, downward from a northwest-southeast-trending ridge. Ravines containing streams flowing northward into Lake Washington are found at the eastern and western borders of mini-basin BLS002. Mini-basins BLS001 and BLS003 slope east-northeast.

Published geologic maps for this area (Booth et al., 2006a) indicate that Vashon Till, a very dense, gray, gravelly, silty sand of glacial origin, underlies most of the project area. Glacial recessional deposits, normally consolidated soils but less dense than glacial till, are mapped on top of the till in scattered locations, and are discussed in depth in the Landslide and Erosion Research section (Section 3.3). Mini-basin BLS002 sits on glacial till. However, in the far west of the project area, bordering Lakeridge Park, is a small string of Vashon Recessional Outwash Deposits (Booth et al., 2006a).

3.4.3 Site Reconnaissance

Mini-basins BLS001 and BLS003. A drive-by reconnaissance of mini-basins BLS001 and BLS003 was conducted on January 16, 2008. In general, the project area is predominantly single-family homes with yards, as well as schools and Bryn Mawr Park. Some of the homes are on steep slopes, many with rock retaining walls. There are stormwater ditches on the edges of many streets, and there are no sidewalks. These stormwater ditches may infiltrate and impact

shallow groundwater. Ravines are noted in the Landslide and Erosion Research section (Section 3.3).

In mini-basin BLS001, we found active groundwater seeps along the rockery walls upslope (to the west) of 82nd Avenue South, between the streets of South 120th Street to South 122nd Street (Figure 12). Groundwater seeps were present along slopes in the southern part of mini-basin BLS001, along 84th Avenue South and the upslope west of 84th Avenue South. Groundwater seeps were also found above Rainer Avenue North at the eastern limits of mini-basin BLS001. The seeps are likely an indication of shallow or perched groundwater in the project area.

We observed iron-oxide staining associated with some of the groundwater seeps encountered in mini-basin BLS001 during the site reconnaissance. We do not know the cause of the staining, but it has been known to occur from groundwater seeping out of fractures in bedrock, which may underlie the till.

Mini-basin BLS002. A drive-by reconnaissance of the mini-basin was conducted on May 1, 2008. In general, the mini-basin is predominantly single-family homes with yards, and no sidewalks. Some of the homes are on steep slopes, and the roads are terraced upward toward the south. Along the western boundary of mini-basin BLS002 is a ravine containing Taylor Creek, which is situated in Lakeridge Park, and a smaller creek and ravine are in the eastern end of the site. Ravines are discussed further in Landslide and Erosion Research (Section 3.3), and creeks are discussed in Wetlands, Streams, and Wildlife Review (Section 3.2).

In mini-basin BLS002, there are scattered stormwater ditches on the edges of several streets. Some of the stormwater ditches had standing or flowing water. In certain areas, water entering the storm basins came from drains from the neighboring properties, likely indicating the presence of shallow groundwater. These ditches may infiltrate and impact shallow groundwater.

Minor groundwater seeps were found on South Sunnycrest Road and South Laurel Street. Slightly north of the project area are seeps on South Ryan Street, and on Rainier Avenue South, north of South Lakeridge Drive. Surface sloughing at 10670 Forest Avenue South appears to be partially due to groundwater. The seeps and surface sloughing are likely an indication of shallow or perched groundwater in the project area.

3.4.4 Groundwater Occurrence

Shallow groundwater occurs in the project area, as noted in our observation of seeps during the reconnaissance. In general, where glacial till is encountered in the project area, relatively low volumes of groundwater would likely occur because of the low permeability of the till. At the western edge of mini-basin BLS002, more groundwater might be encountered, depending on the extent of the recessional outwash sand deposits into the project area.

Mini-basin BLS002. During our job file review, we found records scattered throughout mini-basin BLS002. From 11221 Crestwood Drive South, ½ block to the south of the mini-basin, a report indicated groundwater at a depth of 35 feet bgs. On the northeastern edge of the project site at 10880 Rainer Avenue South, groundwater was not encountered in a boring to the depth of 12.5 feet bgs. A block to the northwest of the project area, by the intersection of South Ryan Street and Forest Avenue South, groundwater was at 25 feet bgs, and the report noted that sandy, advanced outwash soils were found, though they have not been mapped in the area.

Our Northwest Geomaps database search found projects in areas adjoining mini-basin BLS002. North of the site, at 10228 Rainer Avenue South, groundwater was encountered in some test pits 3 to 5 feet bgs, and soils were described as mottled to indicate the presence of seasonal perched groundwater in the area (Associated Earth Sciences, Inc., 2001). Also to the north, at 7109 South Taft Street, explorations encountered heaving sands, and groundwater was encountered at 8 to 12 feet bgs (Geotech Consultants, Inc., 2002).

Mini-basins BLS001 and BLS003. We found no pertinent records from our job file review. Our Northwest Geomaps search found a geotechnical report from mini-basin BLS003 located at 116th Street South and 80th Avenue South experienced groundwater seepage at 2 and 10 feet bgs in test pits (Earth Consultants, Inc., 1996). In mini-basin BLS001, at 8236 South 123rd Place, groundwater was encountered at 5.5 and 9.0 feet bgs in test pits (Dodds Geosciences, 1994).

3.4.5 Ecology Well Logs

Well records and drilling logs were collected from Ecology for the Skyway project area and immediate surrounding areas. Specific areas included Township 24 North, Range 4 East, Sections 1 and 2; Township 23 North, Range 4 East, Section 12; and Township 23 North,

Range 5 East Sections 6 and 7. Well logs provide depth-to-water information for Table 8 in the following section.

3.4.6 Depth To Water

Depth to groundwater generally depends on the presence of perching layers in relation to the ground surface in the upland areas, as well as the presence of surface water bodies in the lowland areas such as Taylor Creek in mini-basin BLS002 and Lake Washington.

TABLE 8
GROUNDWATER DEPTHS – SKYWAY PROJECT AREA

Township, Range, Section	Location	Depth to Water	Date
23N,4E,1E	Rainier Avenue South and 68th Avenue South (west)	4	June 2004
23N, 4E, 12G	78th Avenue South and South 116th Street	100, 180, 222, 231, 235	1929-1985
23N, 4E, 12R	8214 South 128th Street (south)	9	June 1991

The depth to groundwater in the project area was identified from Washington State Department of Ecology Well Records.

3.4.7 Water-level Fluctuations

No specific water-level fluctuation data were identified. However, based on experience in similar locations, groundwater could perch on top of the glacial till. The amount of water would likely fluctuate seasonally with less water present during the summer and fall, and more water present during the winter and spring or following prolonged rainfall events.

3.4.8 Groundwater Flow Direction

In general, shallow groundwater that perches on top of the glacial till likely follows the surface topography, flowing downhill to the north, toward Lake Washington. In mini-basin BLS001, water may flow eastward as well, toward the Cedar River. Locally, the direction of groundwater flow could be influenced by variability in soil conditions, the presence of surface water, and subsurface structures, including utility trenches.

3.4.9 Conclusions

With respect to the sewer infiltration and construction dewatering activities, small accumulations of groundwater could perch atop the glacial till or exist within coarse-grained lenses in till, such as seen in the groundwater seeps encountered during site reconnaissance. Groundwater in these areas may seasonally contribute to sewer infiltration, but likely do not pose significant problems during excavation activities. Only limited construction dewatering may be necessary in the vicinity of test pits for pipe-bursting activity. Groundwater seeps could be captured or diverted to reduce construction impacts.

All three mini-basins (BLS001, BLS002, and BLS003) have scattered, open stormwater ditches with standing water. The standing water indicates that the area has a high groundwater table which may result in a need for limited construction dewatering.

Greater amounts of groundwater may be encountered in the western border of mini-basin BLS002, based on our in-house records, Northwest Geomaps record review, and geologic map. The western edge of mini-basin BLS002 is near the occurrence of sandy, advanced outwash soils in borings, and strings of outwash deposits are mapped in the adjacent soils. Also, heaving sands were encountered in explorations to the north of the mini-basin BLS002 area, indicating the potential for greater amounts of groundwater.

Excavation activities for pipe-bursting test pits in these sand areas may require construction dewatering to control groundwater inflow into pipe-bursting test pits. Pipe-bursting activity could cause groundwater pressures to rise around the bursting head, making the saturated soils more fluid. In this area, construction methods used in pipe bursting should control soil brought by groundwater inflow between the burst and replacement pipes, to prevent locking of the pipes during installation.

The presence of a wellhead protection area in the project area may require coordination with regulatory agencies. The King County Department of Health is responsible for the wetland protection area. Notification prior to work in the area is recommended and the use of BMPs may be required to protect groundwater resources.

4.0 CLOSURE

The findings and conclusions documented in this report have been prepared for specific application to this project, and have been developed in a manner consistent with that level of care

and skill normally exercised by members of the environmental science profession currently practicing under similar conditions in the area, and in accordance with the terms and conditions set forth in our agreement. The conclusions and recommendations presented in this report are professional opinions based on interpretation of information currently available to us, and are made within the operational scope, budget, and schedule constraints of this project. No warranty, express or implied, is made.

This report was prepared for the exclusive use of King County, Tetra Tech, and their representatives. We have prepared the documents, "Important Information About Your Environmental Site Assessment/Evaluation Report" (Appendix A), "Important Information About Your Wetland Delineation/Mitigation and/or Stream Classification Report" (Appendix B), and "Important Information About Your Geological/Environmental Report" (Appendix C) to assist you and others in understanding the use and limitations of our reports.

SHANNON & WILSON, INC.

Katie L. Walter, P.W.S.
Senior Associate
Natural Resources Manager

William T. Laprade, L.E.G.
Vice President

Richard J. Martin, L.H.G.
Senior Associate

BSK:BXE:RJM:KLW/bsk

5.0 REFERENCES

AGRA Earth & Environment, Inc, 1996, Subsurface exploration and geotechnical engineering report, proposed Village Green residential development, Issaquah, Washington: Report prepared by AGRA Earth & Environment, Inc., Kirkland, Wash., 6-91M-11000, for Urban Design, Inc., Kirkland, WA.

Associated Earth Sciences, Inc., 1992, Top of slope setback recommendations, proposed Farrar subdivision, King County, Washington: Report prepared by Associated Earth Sciences, Inc., Kirkland, Wash., 9201-24H for Walter Farrar, Bellevue, WA.

Associated Earth Sciences, Inc. 2001, Addendum geotechnical report, 10228 Rainer Avenue South, Seattle, Washington: Report prepared by Associated Earth Sciences Inc., Kirkland, Wash., KE97256A for Mortgage Solutions, Bellevue, WA.

Booth, D.B., Troost, K.A., and Wisher, A.P., 2006a, Geologic map of King County, Washington: Seattle, Wash., GeoMapNW, The Pacific Northwest Center for Geologic Mapping Studies, scale 1:100,000.

Booth, D.B., Walsh, T.J., Troost, K.A., and Shimel, S.A., 2006b, Geologic map of the Issaquah 7.5 minute quadrangle, King County, Washington: Seattle, Wash., GeoMapNW, The Pacific Northwest Center for Geologic Mapping Studies, scale 1:24,000.

Dodds Geosciences, 1994, Geotechnical engineering report, the Granger Lots, 82XX to 83XX South 123rd Place, King County, Washington: Report prepared by Dodds Geosciences, Bellevue, Wash., 4131, for Nathan Construction Company, Seattle, Wash.

Earth Consultants, Inc, 1996, Lakeridge Heights, 116th Street South and 80th Avenue, King County Washington: Report prepared by Earth Consultants, Inc., Bellevue, Wash., E-7114, for Bianchi and Berzins, Seattle, WA.

Geotech Consultants, Inc., 2002, Geotechnical engineering study, proposed new residence, south of 7109 South Taft Street, Seattle, Washington: Report prepared by Geotech Consultants, Inc., Bellevue, Wash., JN 02108, for View Property Associates, LLC, Kent, WA.

Golder and Associates, 1989, Site investigation and remedial recommendations, Wildwood slope failure, Issaquah, Washington: Report prepared by Golder and Associates, Redmond, Wash., 893-1066, for City of Issaquah, Issaquah, WA.

Golder and Associates, 1994, Results of confirmatory drilling and remediation concepts, mine subsidence investigation, Wildwood Boulevard and Sunrise Place. S.W., Issaquah, Washington: Report prepared by Golder and Associates, Redmond, Wash., 943-1548.600 for City of Issaquah, Issaquah, WA.

Golder and Associates, 2000, Report to City of Issaquah on groundwater exploration and pumping tests, Lower Issaquah Valley: Report prepared by Golder and Associates, Redmond, Wash., for City of Issaquah, Issaquah, Wash.

King County, 2004, King County critical aquifer recharge areas attachment B: Seattle, Wash., September 17, available: http://dnr.metrokc.gov/wlr/wq/groundwater-maps.htm.

King County, 2007, Groundwater data, King County, Washington: Seattle, Wash., available: http://dnr.metrokc.gov/wlr/wq/groundwater-data.htm#.

King County, 2008, Groundwater data, King County, Washington: Seattle, Wash., available: http://dnr.metrokc.gov/wlr/wq/groundwater-data.htm#.

King County Department of Natural Resources (DNR), 1998, King County groundwater management areas: Seattle, Wash., available: http://dnr.metrokc.gov/wlr/wq/pdf/9808groundwatermgtareas.pdf.

King County Department of Natural Resources (DNR), 2005, Issaquah Creek Valley groundwater management area, mapped water table: Seattle, Wash., available: http://www.kingcounty.gov/environment/waterandland/groundwater/management-areas/issaquah-creek-valley-gwma.aspx

Liesch, B.A., 1955, Records of wells, water levels, and quality of ground water in the Sammamish Lake area, King County, Washington: U.S. Geological Survey, Open File Report 55-96, 193 p.

Liesch, B. A., 1963, Geology and ground-water resources of northwestern King County, Washington: Olympia, Wash., Division of Water Resources, Water supply bulletin 20, 241 p., 3 plates.

Mullineaux, D.R., 1965, Geologic map of the Renton quadrangle, King County, Washington: U.S. Geological Survey.

Shannon & Wilson, Inc., 2001, Geotechnical report, Eastgate park and ride project, interim parking lot: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-09453-001, for KPFF Consulting Engineers, Seattle, Wash., September.

Waldron, H.H.; Liesch, B.A.; Mullineaux, D.R.; and Crandell, D.R., 1962, Preliminary geologic map of Seattle and vicinity, Washington: U.S. Geological Survey miscellaneous geologic investigations Map I-354, scale 1:31,680.

Walsh, T. J., 1984, Geology and coal resources of central King County, Washington: Olympia, Wash., Washington State Division of Geology and Earth Resources Open-File Report 84-3, scale 1:24,000.

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Isaaquah_Hazmat.mxd Date: 07/30/2008 BXE

Gilman Meadows Apts.

King County Fire District #10 Firestation

ISS004

18 Mt. Pilchuck NW

Puget Sound Energy Substation

Fish Hatchery Maintenance Garage

Former Gasoline Station

ISS003

660 Wildwood (exact location unknown)

ISSAQUAH

KING COUNTY

Squak Mountain State Park

Squak Mt/Tiger Mt Corridor

East Fork of Issaquah Creek

Issaquah Creek

Rainier Greenway

Community Center Park

Newport Way NW

Newport Way SW

Front St N

Front St S

NW Holly St

NE Holly St

NE Gilman Blvd

1st Ave NE

NW Firwood Blvd

NW Everwood Dr

NW Datewood Dr

Kalmia Pl NW

Jasmine Pl NW

Indigo Pl NW

Datewood Ct NW

Mount Olympus Dr NW

Dorado Dr NW

Almak Ct NW

Aires Pl NW

Big Bear Pl NW

Newport Quay Dr NW

3rd Ct NW

NW Dogwood St

NE Dogwood St

NW Cherry Pl

1st Ave NW

1st Pl NW

1st Ave NE

1st Pl NE

NE Creek Way

NW Birch Pl

NW Alder Ct

NW Alder Pl

NE Alder St

NE Birch St

3rd Ave NE

2nd Ave NE

5th Ave NE

W Sunset Way

E Sunset Way

SW Mount Pilchuck Pl

Mount Pilchuck Ave SW

Mount Olympus Dr SW

SE Bush St

4th Pl SE

5th Ave SE

SW Clark St

SE Clark St

SE Croston Ln

Mount Baker Dr SW

SW Mount Baker Dr

1st Ave SE

SE Donnelly Ln

SE Darst St

SE Evans Ln

SE Evans St

Mount McKinley Dr SW

Mount Kenya Dr SW

Mount Jupiter Dr SW

Mount Furry Cir SW

Mount Defiance Cir SW

Mountain Park Blvd SW

Mount Logan Dr SW

Mountainside Dr SW

SW Cedarglade Dr

Wildwood Blvd SW

SW Forest Dr

SW Forest Pl

SW Ellerwood St

Highwoods Dr SW

Greenwood Blvd SW

Idylwood Dr SW

Valley View Ln SW

Mine Hill Rd SW

SW Francis Ln

SW Gibson Ln

Hepler Ln SW

Sunrise Pl SW

Ridgewood Cir SW

Ridgewood Pl SW

Squak Mountain Loop SW

Quinalt Ct SW

SE Jones Ln

SE Nyberg Ln

SE Sycamore Creek Ln

Sycamore Dr SE

Hillside Dr SE

SE Crystal Creek Cir

2nd Ave SE

Front St S

Rainier Blvd S

Rainier Blvd N

90

Legend

- Potentially Contaminated Heating Oil Sites
- Other Potentially Contaminated Sites
- City limits
- ISS003 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

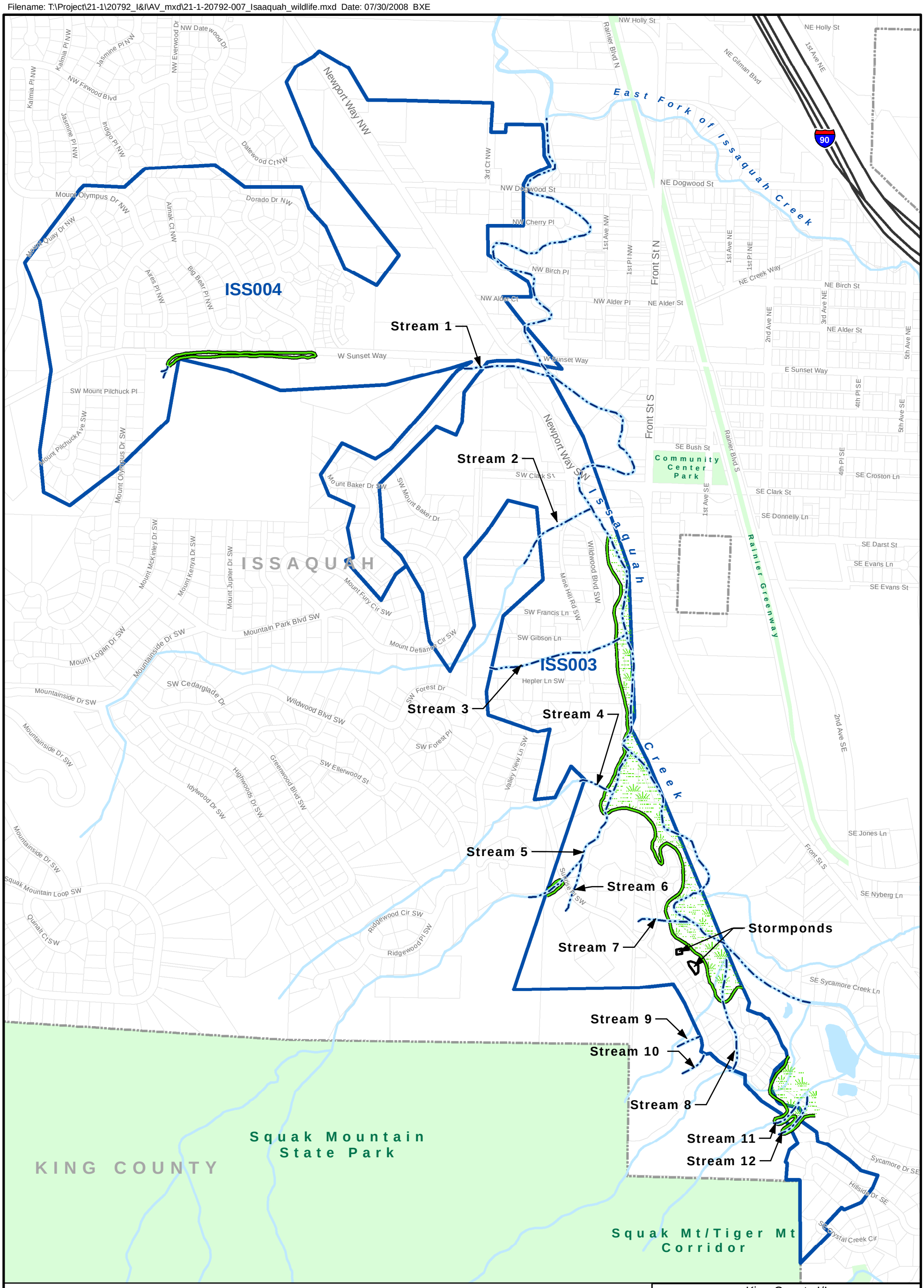
HAZARDOUS MATERIALS RESEARCH ISSAQUAH PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Isaaquah_wildlife.mxd Date: 07/30/2008 BXE



Legend

- Streams observed in project area
- Streams mapped by King County
- City limits
- Wetlands
- ISS001 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Wetland and stream locations are approximate and based on field reconnaisance. Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

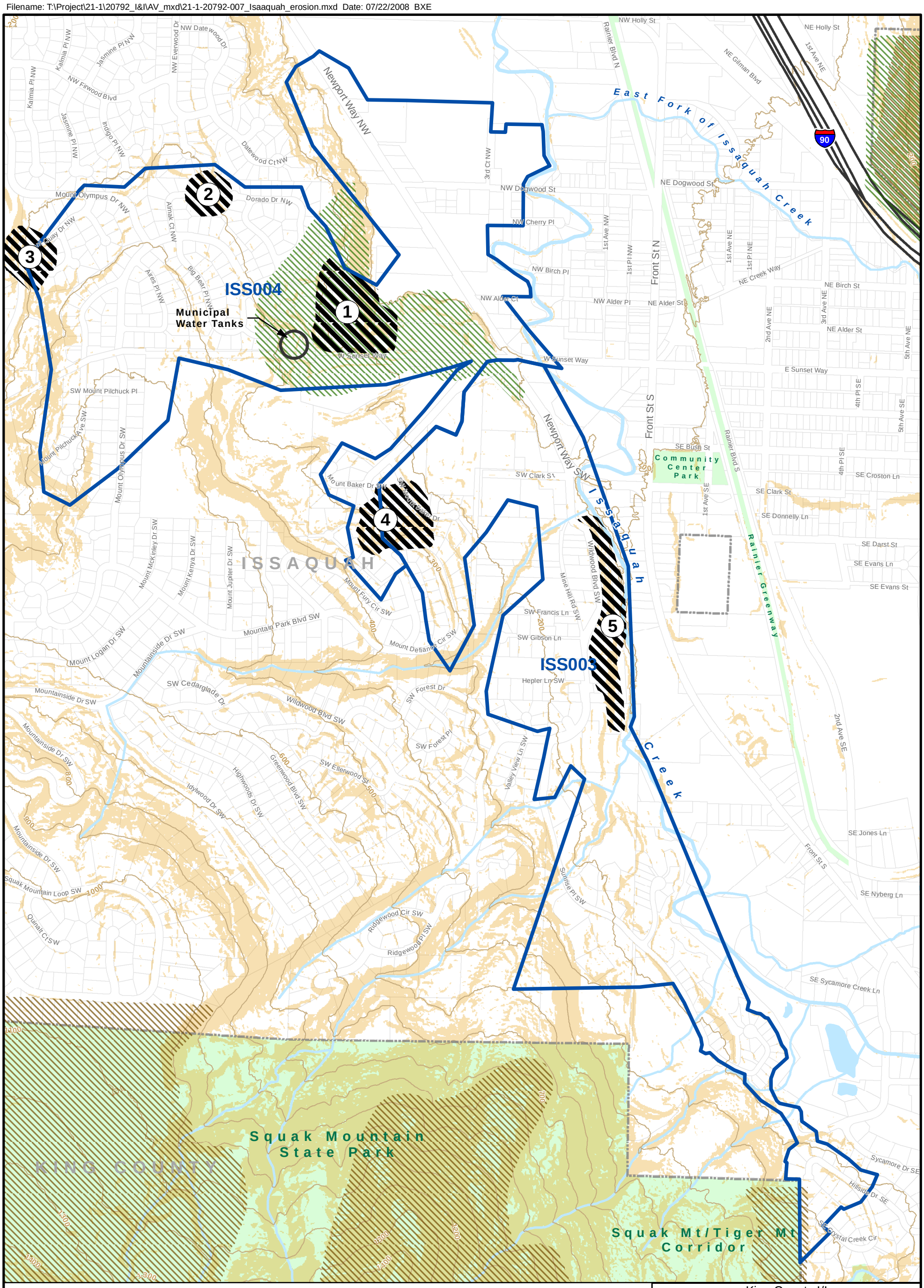
WETLANDS, STREAMS, AND WILDLIFE RESEARCH ISSAQUAH PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Isaaquah_erosion.mxd Date: 07/22/2008 BXE



Legend

- Areas where reduction in I/I may reduce slope stability
- Landslide Hazard Area
- Erosion Hazard Area
- Slopes greater than 40 percent
- City limits
- ISS003 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

NOTE

Erosion and landslide hazard areas and base map layers from King County Stardard data, 2007. Slope derived from LiDAR, Puget Sound LiDAR Consortium.

King County I/I
Environmental Technical Memorandum
King County, Washington

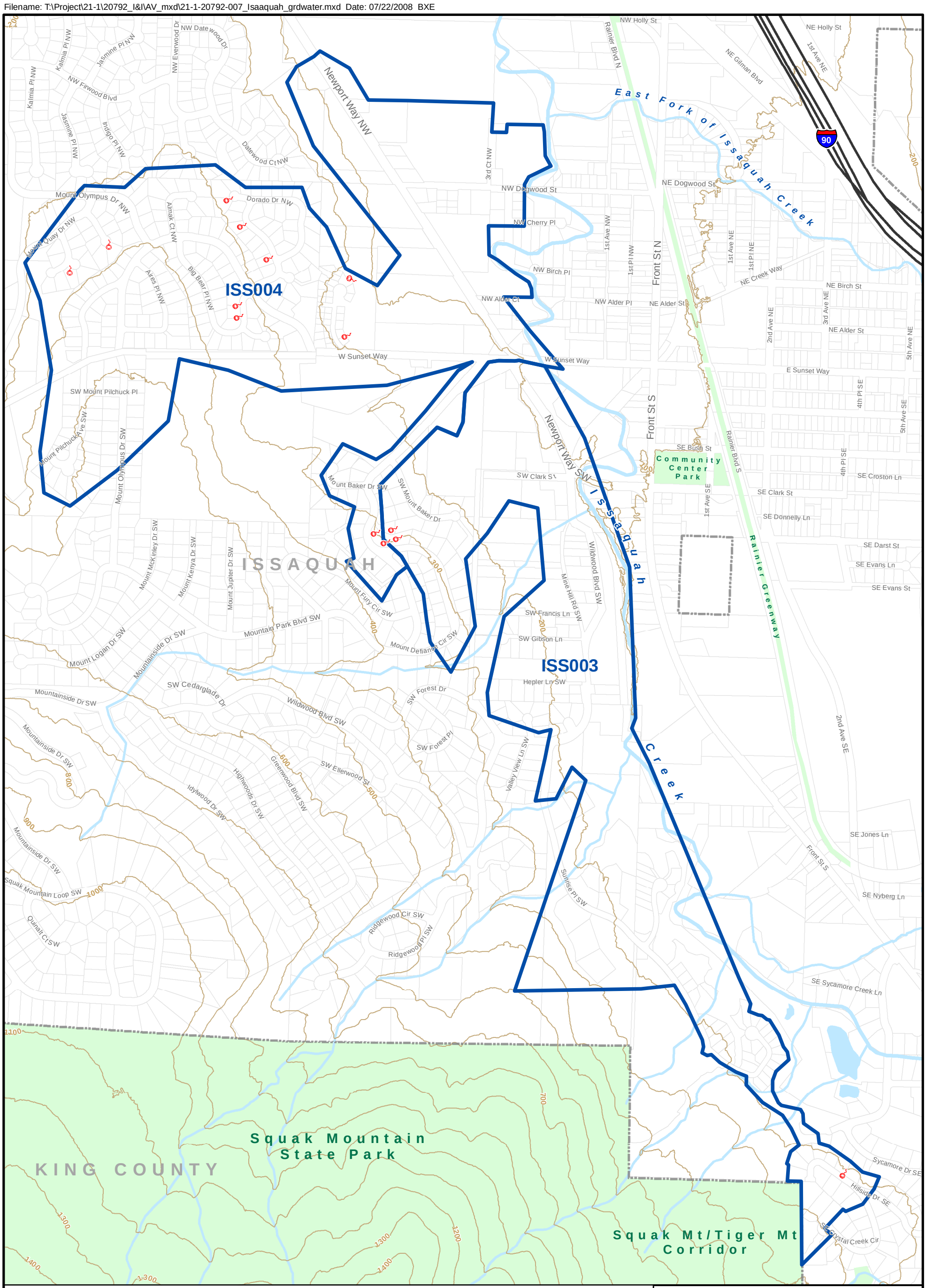
LANDSLIDE / EROSION RESEARCH
ISSAQUAH PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 3

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Isaaquah_grdwater.mxd Date: 07/22/2008 BXE



Legend

- Groundwater Seeds
- City limits
- BLS002 — Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

GROUNDWATER SYSTEMS RESEARCH ISSAQUAH PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 4

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_hazmat.mxd Date: 07/30/2008 BXE

Schuck's Auto Supply
76 Gas Station
Eastgate Plaza Custom Cleaners
Comcast Cable Communications Bellevue
Hotel
Hewlett-Packard Company
WA Environmental Pro T
Arrow Lumber
Bellevue Community College
BEL012
BEL011
East Tributary Vasa Creek
Vasa Creek
Horizon Heights
Whispering Heights
Lattawood Park
Collingwood Mini Park
The Heights Open Space
Collingwood Open Space
Silverleaf Park
Lakemont Highlands Park and Open Space
Lakemont Park and Open Space
Saddleback Park
BELLEVUE
KING COUNTY
SE 37th St
SE 38th St
SE 39th St
SE 40th Pl
SE 41st Pl
SE 41st St
SE 42nd St
SE 42nd Pl
SE 42nd Ct
SE 43rd St
SE 43rd Pl
SE 44th Pl
SE 44th Way
SE 45th St
SE 45th Pl
SE 45th Way
SE 46th St
SE 46th Pl
SE 46th Way
SE 47th St
SE 47th Pl
SE 48th St
SE 48th Dr
SE 49th St
SE 49th Pl
SE 50th St
SE 51st St
SE 53rd Pl
SE 54th Pl
SE 54th Ct
SE 56th Pl
SE Newport Way
SE 35th Pl
SE 35th St
SE 34th St
SE Allen Rd
90

Legend

- Potentially Contaminated Heating Oil Sites
- Other Potentially Contaminated Sites
- City limits
- BEL011 Minibasin boundary and label

0 0.1 0.2 0.4
Scale in Miles

N

NOTE

Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

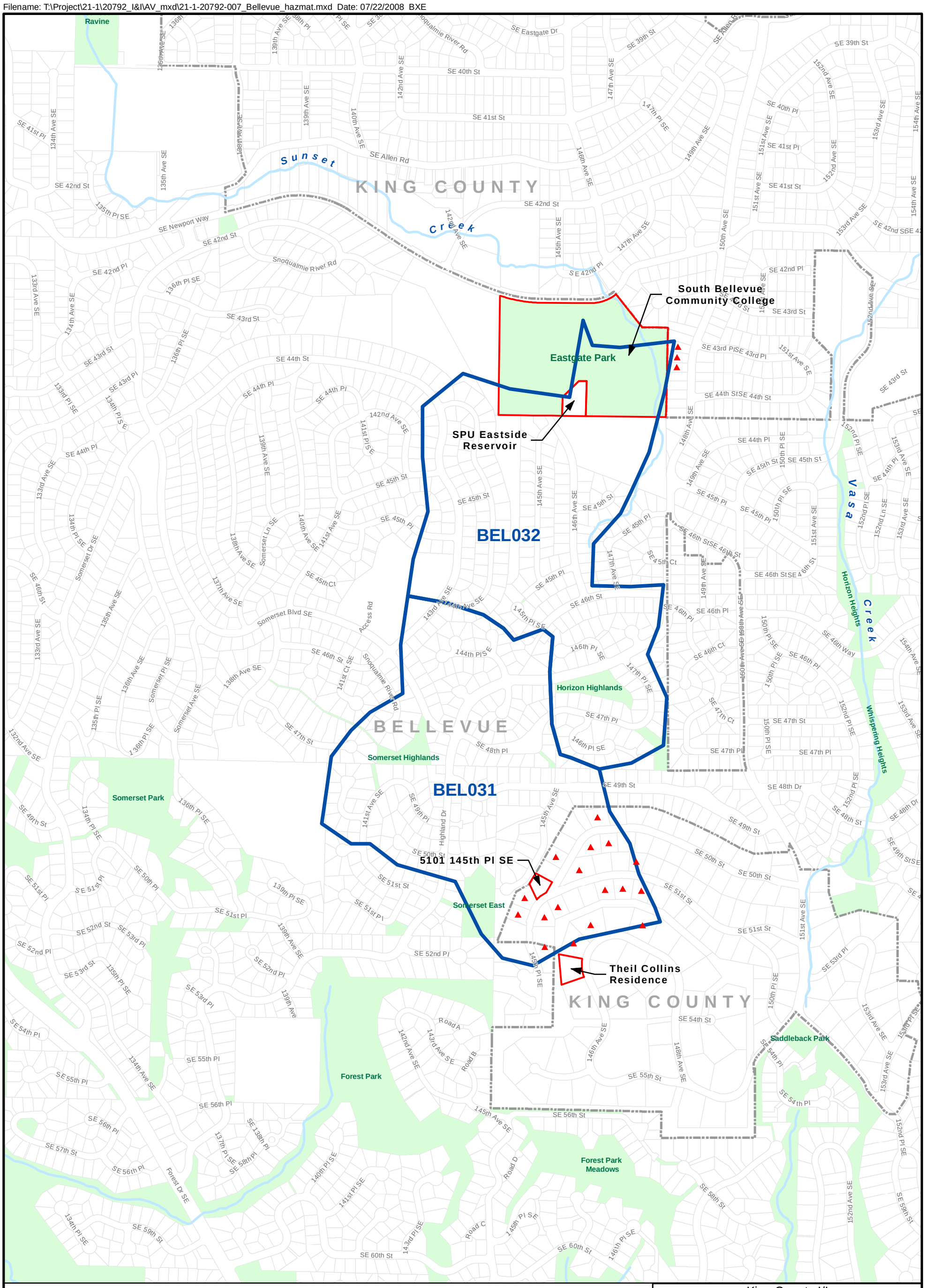
HAZARDOUS MATERIALS RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 5
Sheet 1 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_hazmat.mxd Date: 07/22/2008 BXE



King County I/I
Environmental Technical Memorandum
King County, Washington

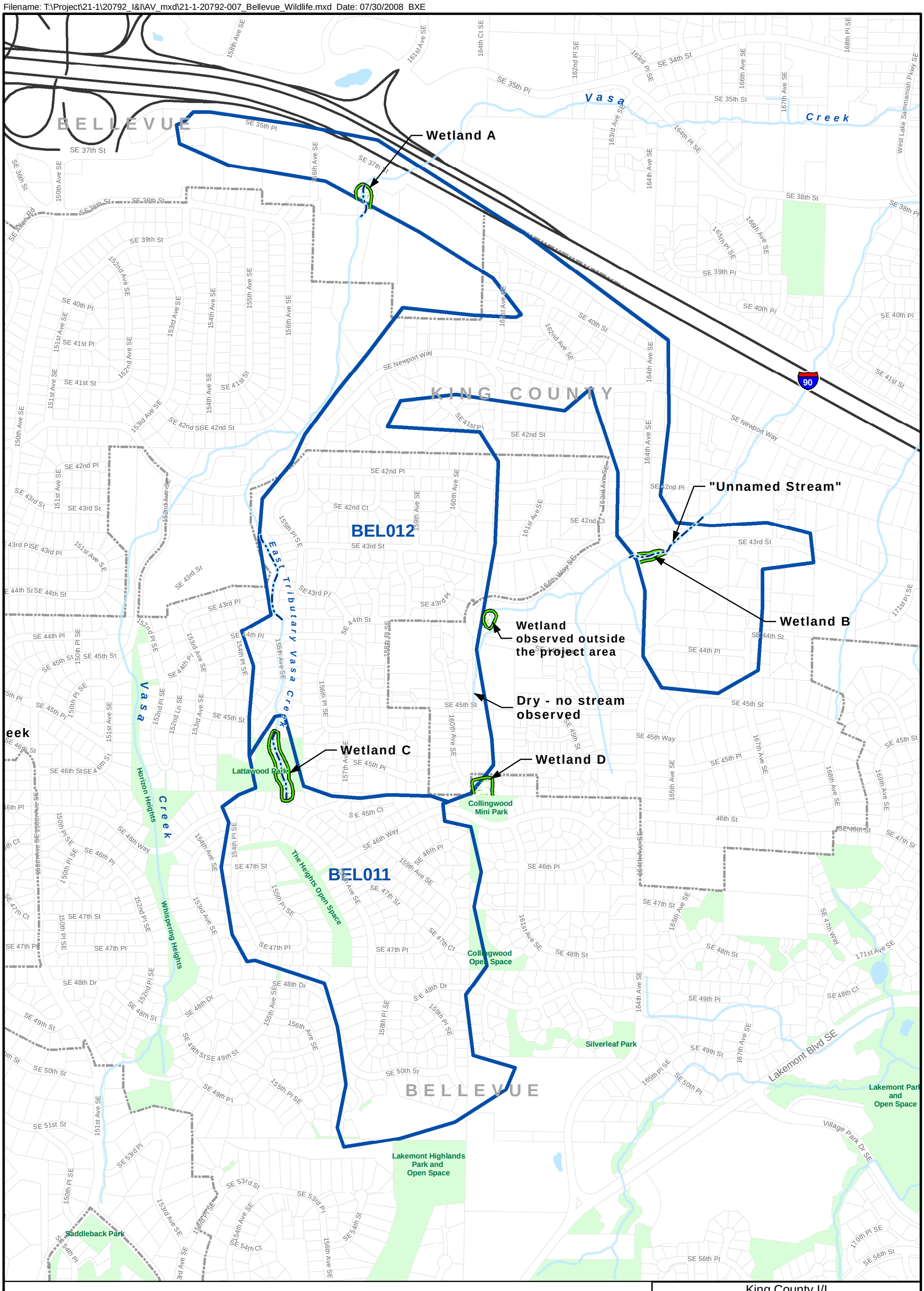
HAZARDOUS MATERIALS RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 5
Sheet 2 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_Wildlife.mxd Date: 07/30/2008 BXE



Legend

- Streams observed in project area
- Streams mapped by King County
- City limits
- Wetlands
- BEL011 — Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

NOTE

Wetland and stream locations are approximate and based on field reconnaisance. Base map layers from King County Stardard data, 2007.

N

King County I/I
Environmental Technical Memorandum
King County, Washington

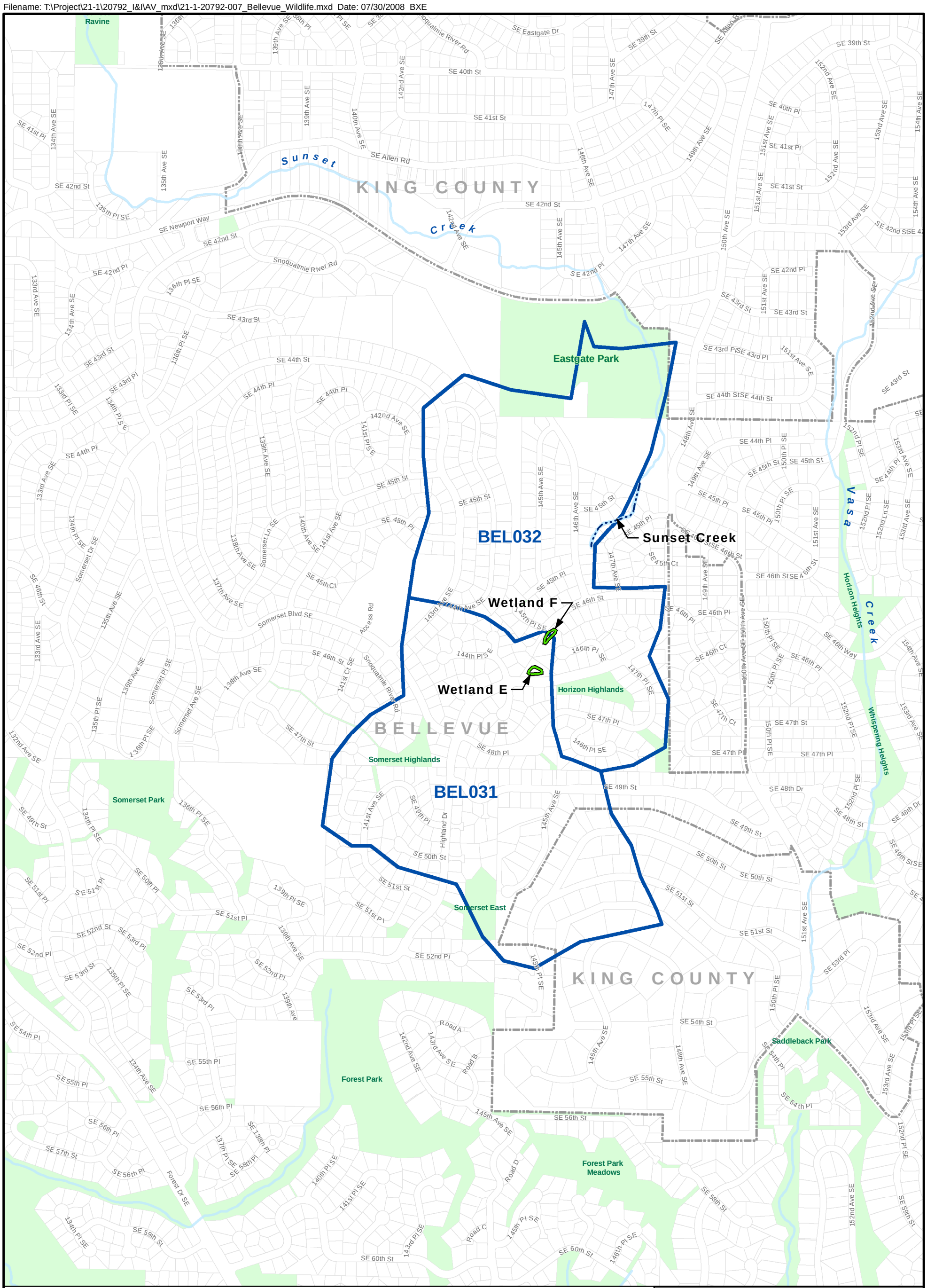
WETLANDS, STREAMS, AND WILDLIFE RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 6
Sheet 1 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_Wildlife.mxd Date: 07/30/2008 BXE



Legend

- Streams observed in project area
- Streams mapped by King County
- City limits
- Wetlands
- BEL011 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Wetland and stream locations are approximate and based on field reconnaisance. Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

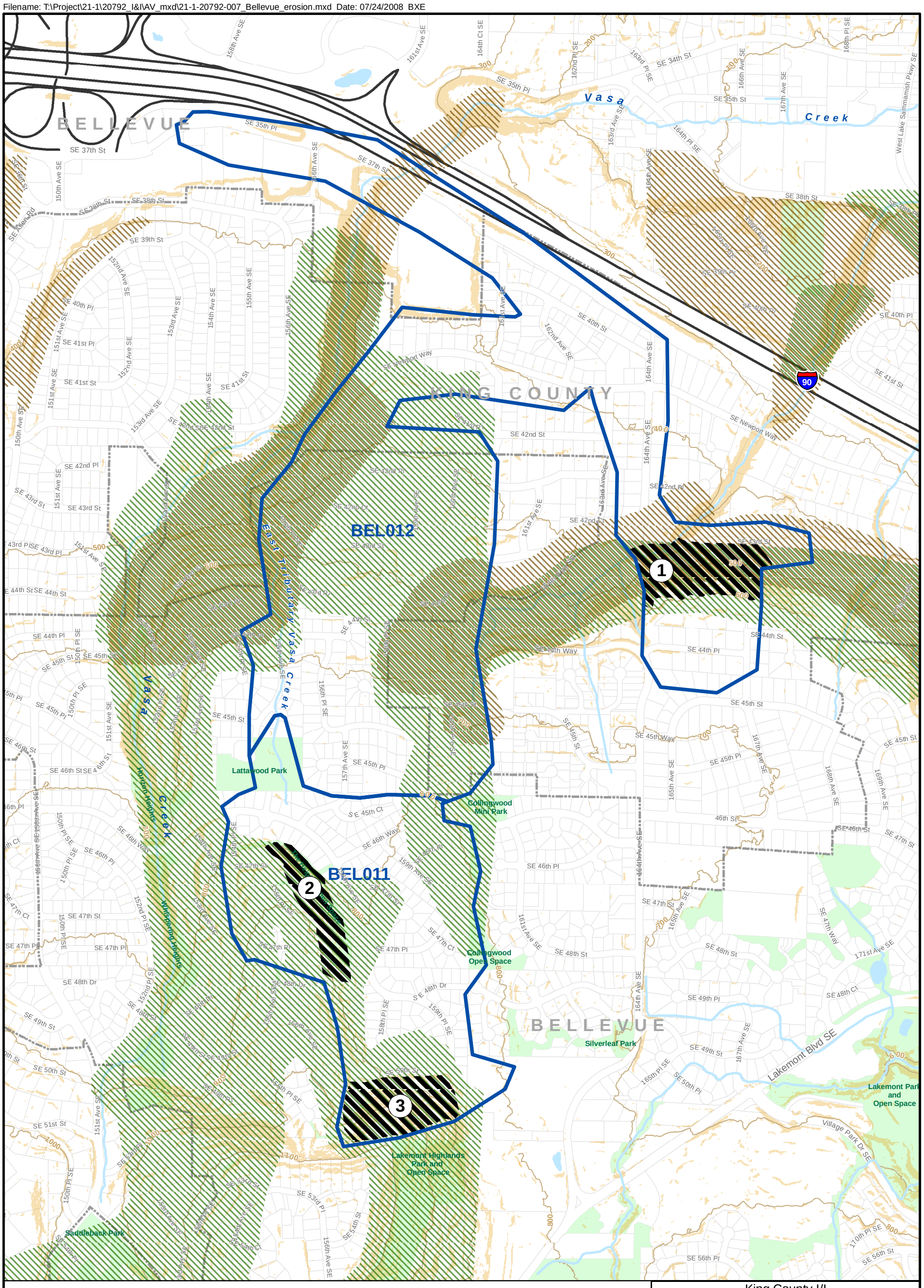
WETLANDS, STREAMS, AND WILDLIFE RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 6
Sheet 2 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_erosion.mxd Date: 07/24/2008 BXE



Legend

- Areas where reduction in I/I may reduce slope stability
- Landslide Hazard Area
- Erosion Hazard Area
- Slopes greater than 40 percent
- City limits
- BEL011 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Erosion and landslide hazard areas and base map layers from King County Stardard data, 2007. Slope derived from LiDAR, Puget Sound LiDAR Consortium.

King County I/I
Environmental Technical Memorandum
King County, Washington

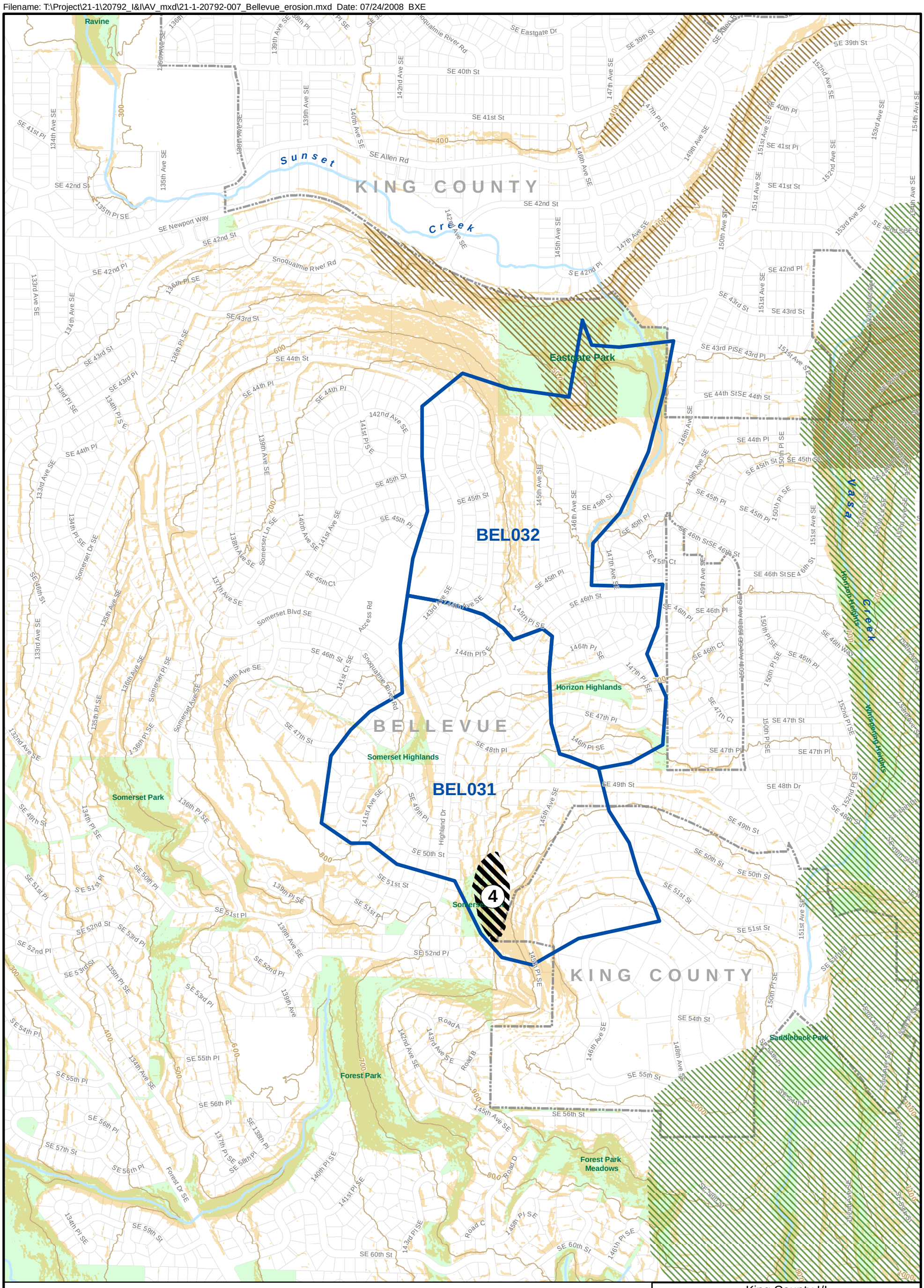
LANDSLIDE / EROSION RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 7
Sheet 1 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_erosion.mxd Date: 07/24/2008 BXE



Legend

- Areas where reduction in I/I may reduce slope stability
- Landslide Hazard Area
- Erosion Hazard Area
- Slopes greater than 40 percent
- City limits
- BEL011 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Erosion and landslide hazard areas and base map layers from King County Stardard data, 2007. Slope derived from LiDAR, Puget Sound LiDAR Consortium.

King County I/I
Environmental Technical Memorandum
King County, Washington

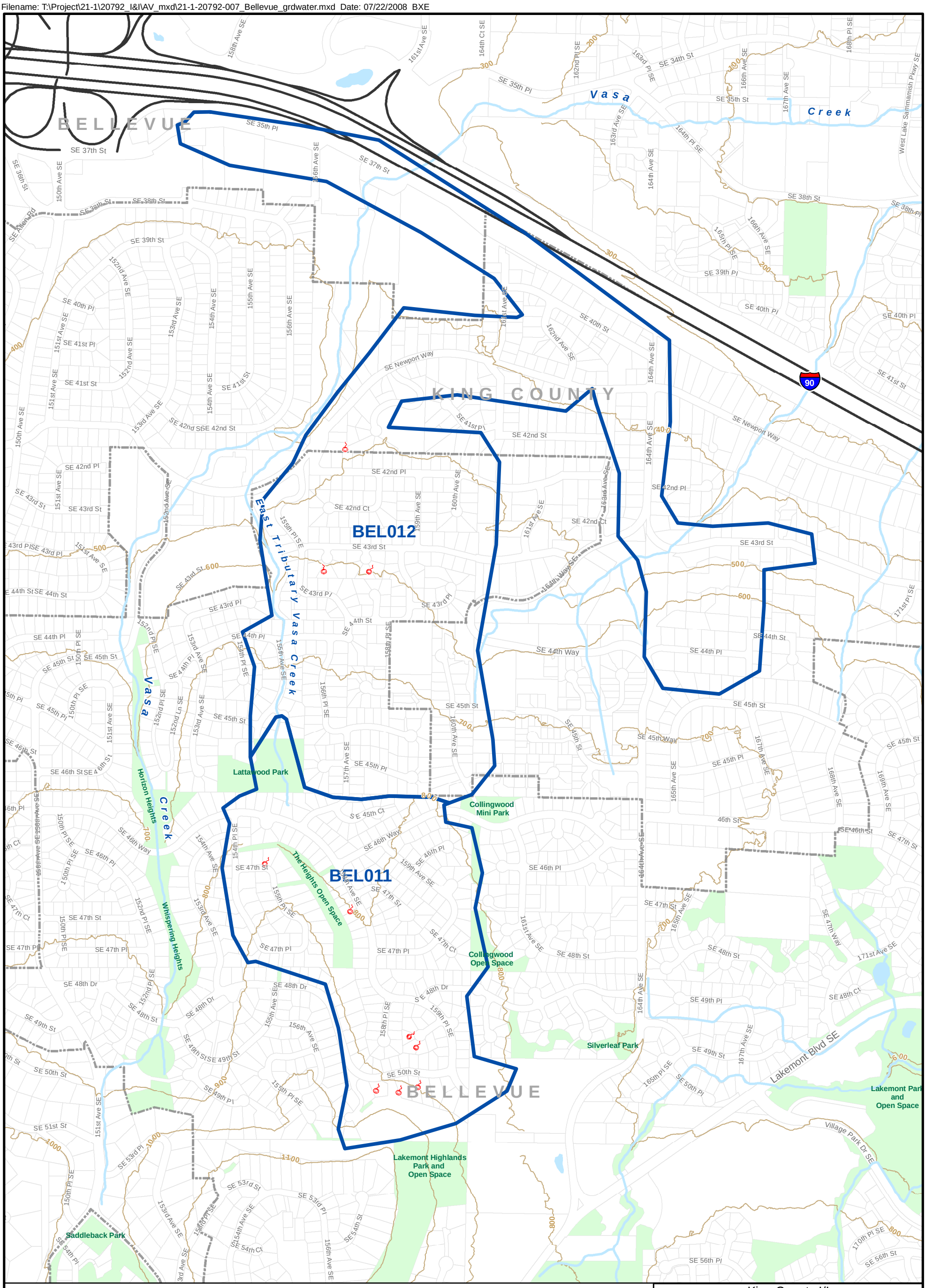
LANDSLIDE / EROSION RESEARCH
BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 7
Sheet 2 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_grdwater.mxd Date: 07/22/2008 BXE



Legend

- Groundwater Seeps
- City limits
- BLS002 — Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

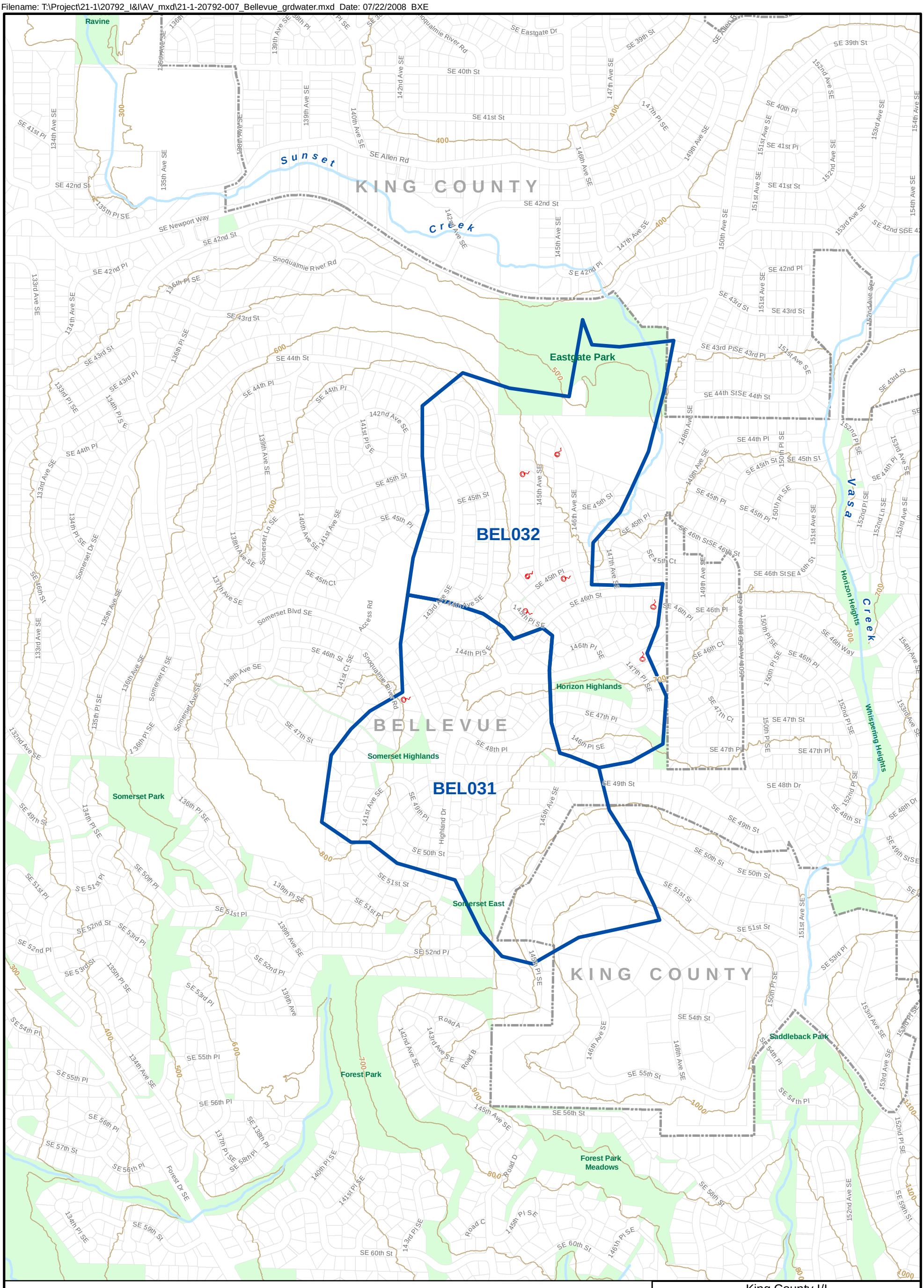
GROUNDWATER SYSTEMS RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 8
Sheet 1 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Bellevue_grdwater.mxd Date: 07/22/2008 BXE



Legend

- Groundwater Seeps
- City limits
- BLS002 Minibasin boundary and label

NOTE

Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

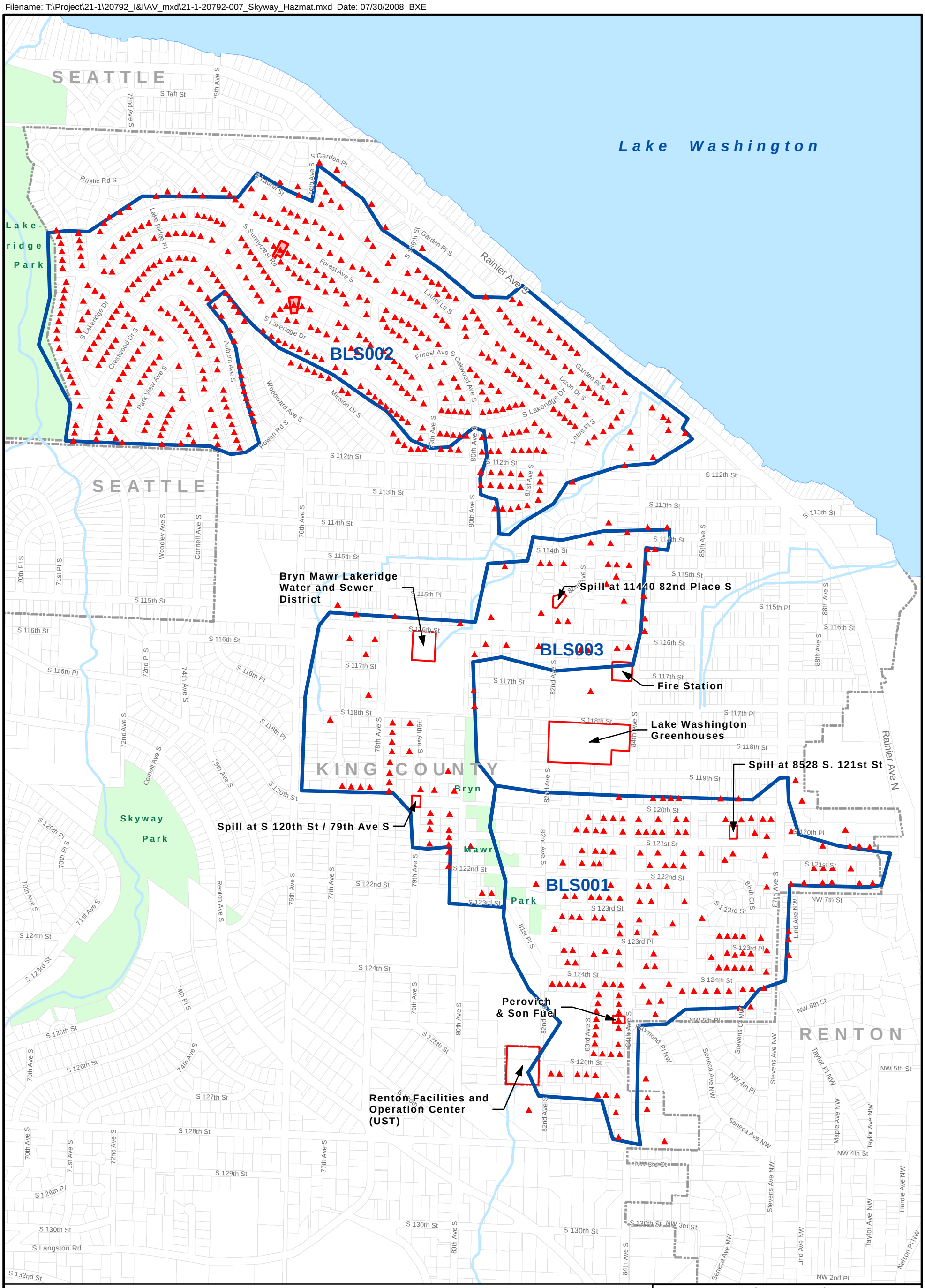
GROUNDWATER SYSTEMS RESEARCH BELLEVUE PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 8
Sheet 2 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Skyway_Hazmat.mxd Date: 07/30/2008 BXE



King County I/I
Environmental Technical Memorandum
King County, Washington

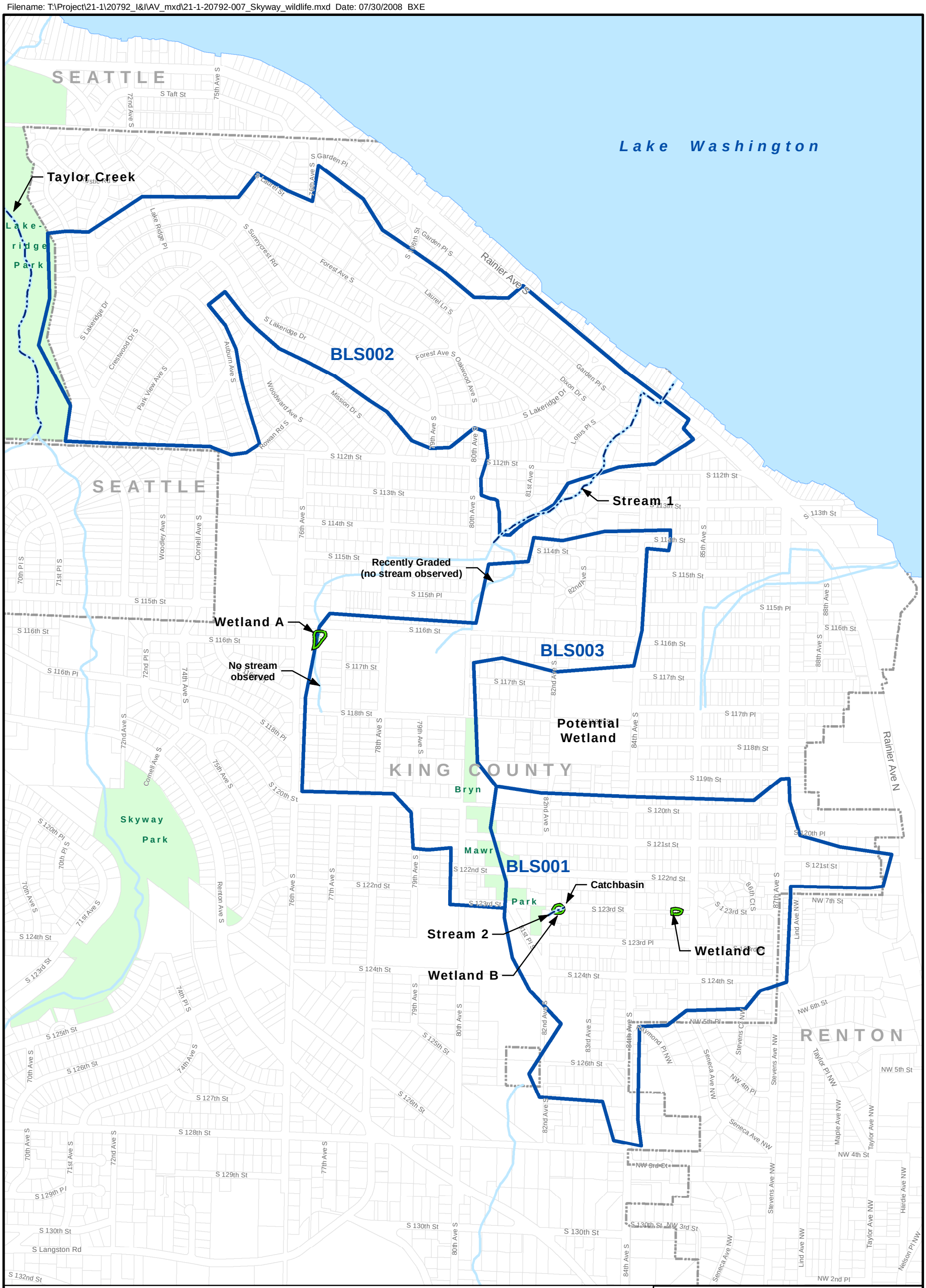
HAZARDOUS MATERIALS RESEARCH SKYWAY PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 9

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Skyway_wildlife.mxd Date: 07/30/2008 BXE



King County I/I
Environmental Technical Memorandum
King County, Washington

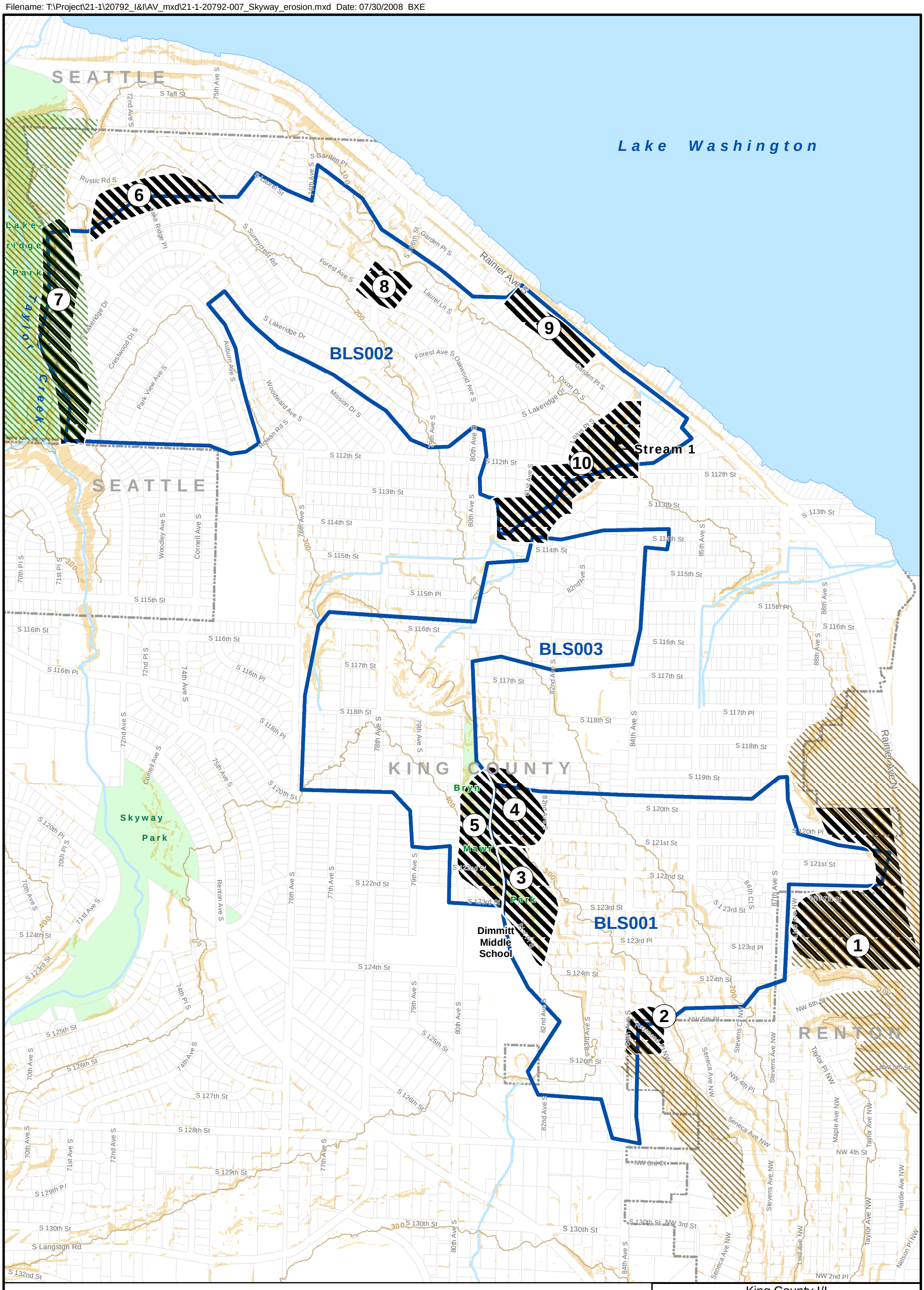
WETLANDS, STREAMS, AND WILDLIFE RESEARCH SKYWAY PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 10

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Skyway_erosion.mxd Date: 07/30/2008 BXE



Legend

- Areas where reduction in I/I may reduce slope stability
- Landslide Hazard Area
- Erosion Hazard Area
- Slopes greater than 40 percent
- City limits
- BLS001 Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Erosion and landslide hazard areas and base map layers from King County Stardard data, 2007. Slope derived from LiDAR, Puget Sound LiDAR Consortium.

King County I/I
Environmental Technical Memorandum
King County, Washington

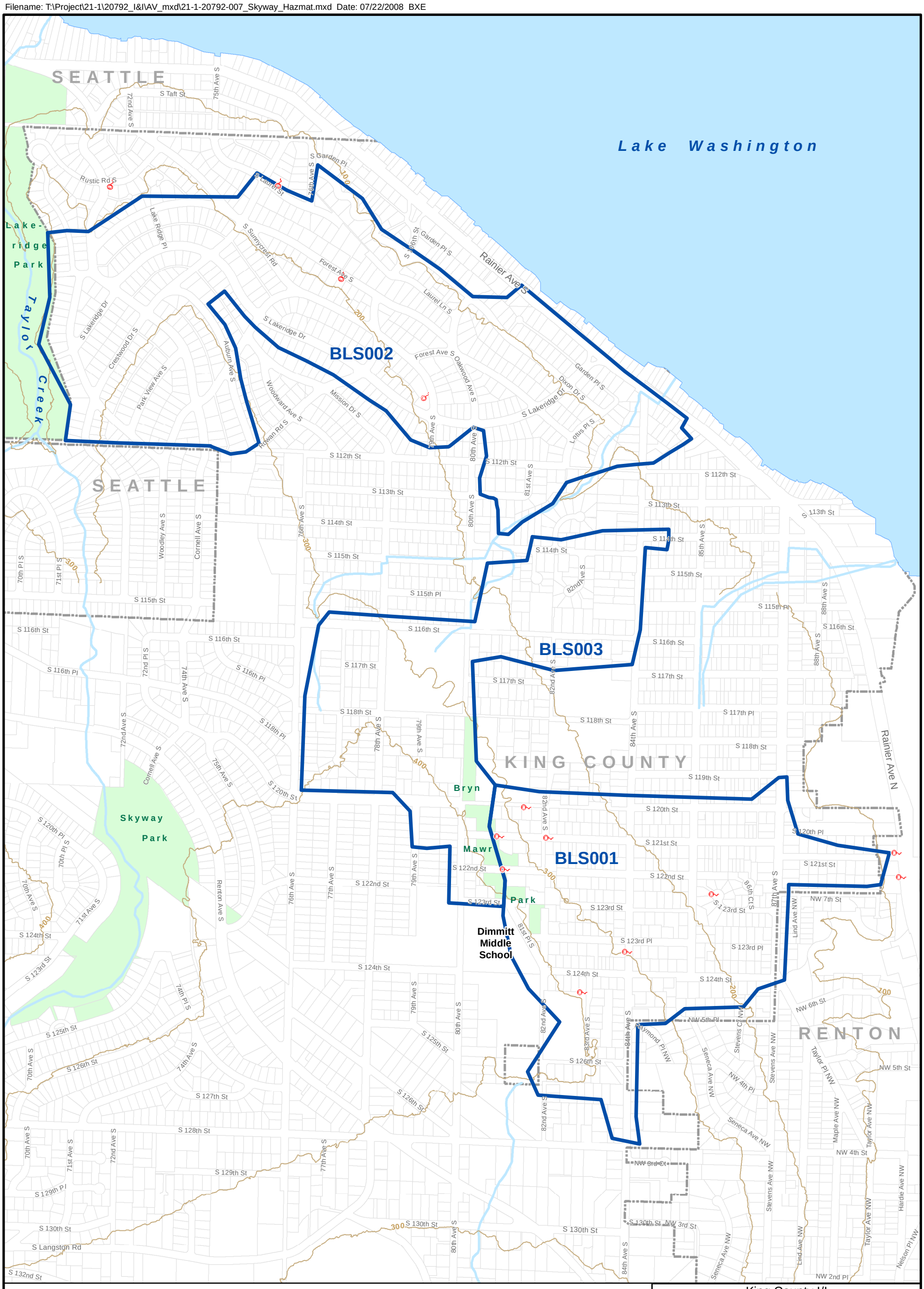
LANDSLIDE / EROSION RESEARCH
SKYWAY PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 11

Filename: T:\Project\21-1\20792_I&I\AV_mxd\21-1-20792-007_Skyway_Hazmat.mxd Date: 07/22/2008 BXE



Legend

- Groundwater Seeps
- City limits
- BLS002 — Minibasin boundary and label

0 0.1 0.2 0.4

Scale in Miles

N

NOTE

Base map layers from King County Stardard data, 2007.

King County I/I
Environmental Technical Memorandum
King County, Washington

GROUNDWATER SYSTEMS RESEARCH
SKYWAY PROJECT AREA

March 2009 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 12

King County

Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report

APPENDIX B.
SKYWAY PROJECT AREA DRAINAGE COMPLAINTS

April 2009

TABLE - 1
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 001

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
Source : Adjacent Property/ Development									
11	1	1997-0480	DRAINAGE	C	2/18/1997	3/25/1997	S 8539 124TH ST	723059073	SHEET FLOW FROM ADJ PROP IMP PVT PROP
11	2	1997-0480	DRAINAGE	NDA	6/2/1997	12/31/1997	S 8539 124TH ST	723059073	SHEET FLOW FROM ADJ PROP IMP PVT PROP
11	3	1997-0480	DRAINAGE	R	3/25/1997	6/2/1997	S 8539 124TH ST	723059073	SHEET FLOW FROM ADJ PROP IMP PVT PROP
16	1	2004-0450	DTA	C	5/27/2004	6/30/2004	S 8512 124TH ST	1180008210	Inceased runoff from neighboring properties. Open DDES code enforcement (E0460205) ongoing.
18	1	1994-0897	FLOODING	C	12/8/1994	12/20/1994	S 8518 123RD PL	1180007045	DISCHARGE FROM PVT DRAIN
19	1	1999-0047	EROSION	C	1/19/1999	2/12/1999	S 8211 123RD PL	1180007865	PVT LOT DEVE DRNG ISSUES
23	1	1987-0994	DRNG	C	10/2/1987	10/28/1987	S 8222 123RD PL	1180007405	"NEW HOUSE" CAUSING RUNOFF
30	2	1996-0684	FLDG	C	3/6/1996	4/12/1996	S 8217 123RD ST	1180007245	SHEET FLOW FROM ADJ PROPERTY
43	4	1996-1905	DRNG	C	11/8/1996	12/13/1996	12117 85TH AVE S	1180005680	SHEET FLOW IMP SEVERAL PROP DRNG MAINT
43	5	1996-1905	DRNG	R	12/13/1996	2/21/1997	12117 85TH AVE S	1180005680	SHEET FLOW IMP SEVERAL PROP DRNG MAINT
44	1	1990-1379	DRNG	C	10/11/1990	10/24/1990	12200 85TH AVE S	1180005471	NEIGHBOR ENCLOSED DITCH
49	1	1996-0406	PONDING	C	2/12/1996	2/26/1996	S 8549 120TH ST	1180005310	NEIGHBORS DOWNSPOUTS DRAIN ONTO HIM
49	2	1996-0406	PONDING	R	2/26/1996	7/3/1996	S 8549 120TH ST	1180005310	NEIGHBORS DOWNSPOUTS DRAIN ONTO HIM
57	1	2007-0227	RFN	C	3/29/2007	4/24/2007	S 8213 121ST ST	1180005748	Pipe from neighbor drains to prop. Inv found newer houses in area. Possible groundwater issues. Neighbor proposing p ipe solution.
60	1	1991-0743	DRAINAGE	C	6/11/1991	6/22/1991	S 8118 122ND ST	1180006050	PLUGGES PRIVATE SYSTEM
60	2	1991-0743	DRAINAGE	SR	6/11/1991	11/19/1992	S 8118 122ND ST	1180006050	PRIVATE SYSTEM
60	3	1991-0936	DRAINAGE	C	8/20/1991	9/4/1991	S 8188 122ND ST	1180006050	DRAINAGE FROM PARK
63	2	1998-0107	DRAINAGE	C	2/10/1998	2/23/1998	S 8115 120TH ST	1180004750	ADJACENT SFR IMPACT TO GRND WATER DISCH
64	1	1987-0541	DRNG	C	3/25/1987	5/18/1987	S 8217 120TH ST	1180004912	SURFACE WATER-DUE TO NEW CONSTRUCTION
Source : Road									
8	1	1979-0098	DRNG	C	7/12/1979	7/12/1979	8500 S 125TH ST	7961500070	RUNOFF/BRYN MAWR AREA
21	1	2004-0808	DTA	C	10/26/2004	11/17/2004	S 8223 123RD PL	1180007875	Water from private driveway impacting KC road. Possible NDAP?
21	2	2004-0808	DTA	R	11/17/2004	12/15/2004	S 8223 123RD PL	1180007875	Water from private driveway impacting KC road. Possible NDAP?
21	3	2004-0808	DTA	NDA-C	12/15/2004	12/1/1900	S 8223 123RD PL	1180007875	Water from private driveway impacting KC road. Possible NDAP?
33	2	1991-0825	DRAINAGE	C	7/17/1991	10/4/1991	S 8214 123RD ST	1180006530	WATER FROM UPHILL/CULVERT
43	1	1995-0156	RDRUNOFF	C	2/16/1995	2/1/1995	12117 85TH AVE S	1180005680	SHEET FLOW FROM RD R/W
43	2	1995-0156	RDRUNOFF	R	1/8/1996	1/8/1996	12117 85TH AVE S	1180005680	SHEET FLOW FROM RD R/W
43	3	1995-0156	RDRUNOFF	RN	2/1/1995	1/8/1996	12117 85TH AVE S	1180005680	SHEET FLOW FROM RD R/W
44	2	2001-0579	DDM	C	9/26/2001	10/11/2001	12200 85TH AVE S	1180005471	SHEET FLOW FROM ROADWAY BYPASSING CATCH BASIN
46	1	1994-0617	ILL/PIPE	E	9/19/1994	10/6/1997	12133 87TH AVE S	1180006780	SUBSTANDARD PIPE IN R/W
46	2	1994-0617	ILL/PIPE	ER	8/19/1994	9/19/1994	12133 87TH AVE S	1180006780	SUBSTANDARD PIPE IN R/W
50	1	1983-0396		C	4/21/1983	4/21/1983	8555 S 120TH ST	1180005305	RD SHOULDER WASHOUT
50	2	1994-0654	DEBRIS	C	9/12/1994	11/4/1994	S 8555 120TH ST	1180005305	WATER FROM ROADWAY
50	3	1997-0321	FLDG	C	1/23/1997	3/11/1997	S 8555 120TH	1180005305	SHEET FLOW FROM ROAD IMP PVT PROB
51	1	1994-0651	FLOODING	C	9/9/1994	11/4/1994	S 8428 121ST ST	1180005180	WATER FROM ROADWAY GETS OVER EX BERM
Source : Broken/Inadequate Drainage System									
7	1	1980-0121	DRNG	C	9/2/1980	9/2/1980	12426 84TH AVE S	723059068	PLUGGED SYSTEM WEST OF 84TH AVE S
20	3	2004-0561	WQI	WQR	7/26/2004	9/30/2004	S 8217 123RD PL	1180007880	GRAY WATER, DUE TO BROKEN SEWER LINE CAMERON WORKED WITH SKYWAY SEWER AND GOT PROBL EM RESOLVED
53	1	1999-0113	DRAINAGE	C	2/4/1999	2/17/1999	S 8232 122ND ST	1180005890	APPARENT ABANDONED PVT DRNG SYSTEM

TABLE - 1
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 001

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
Source : Ground water									
6	1	1998-0455	DRAINAGE	C	7/7/1998	8/14/1998	12445 84TH AVE S	3379200150	GRND WTR DISC IMP ROAD R/W
8	2	2001-0751	DDM	C	11/26/2001	12/9/2001	S 8500 125TH ST	7961500070	LOT DRAINGE PROBLEM. APPARENT GROUNDWATER IMPACT
9	1	1998-0203	DRAINAGE	C	3/24/1998	4/9/1998	12422 84TH AVE S	723059074	GROUNDWATER IMPACT TO PVT PROP
20	1	2001-0446	DDM	C	7/24/2001	3/8/2002	S 8217 123RD PL	1180007880	GROUND WATER CONVEYANCE DISCHARGE ONTO ROADWAY.
20	2	2001-0446	DDM	R	9/1/2001	3/8/2002	S 8217 123RD PL	1180007880	GROUND WATER CONVEYANCE DISCHARGE ONTO ROADWAY.
48	1	1997-0565	DRAINAGE	C	3/17/1997	3/28/1997	12100 87TH AVE S	4204400010	GROUND WATER MINIMAL ROAD IMPACT
63	3	2002-0800	DTA	C	12/20/2002	6/17/2003	8115 S 120TH ST	1180004750	GROUNDWATER IMPACT TO PVT PROP. APPEARS FLOW THROUGH ROCKERY. WILL PROVIDE CONTRACT OR/ENGINEER LIST
Source : Other Complaints									
1	1	1987-0191	DRNG	C	1/15/1987	3/16/1987	S 8060 120TH ST	1223049020	ICE-WATER ON ROADWAY
2	1	1988-0710	DRNG	C	11/7/1988	11/25/1988	S 8206 120TH ST	1223049164	BY PASSES C/B & FLDS PROPERTY 88-0712
3	1	1999-0145	EASEMENT	E	8/1/1999	7/30/2001	11902 83RD AVE S	1223049175	CONSTRUCTION WITHIN EASEMENT/BIOSWALE
3	2	1999-0145	EASEMENT	FCR	2/17/1999	7/30/2001	11902 83RD AVE S	1223049175	CONSTRUCTION WITHIN EASEMENT/BIOSWALE
3	3	1999-0145	EASEMENT	R	2/23/1999	7/30/2001	11902 83RD AVE S	1223049175	CONSTRUCTION WITHIN EASEMENT/BIOSWALE
4	1	1996-0969	SEDIMENT	C	4/24/1996	5/16/1996	11918 83RD AVE S	1223049187	ALLEGED SEDIMENT IMPACT TO CURB & GUTTE
5	1	1995-0833	FLOODING	C	10/4/1995	10/27/1995	12448 83RD AVE S	3379200210	DRAINAGE FLOWS DOWN D/W OHLDRDCORD
10	1	1977-0064	DRNG	C	11/15/1977	11/15/1977	8433 S 124TH ST	723059087	DISRUPTED/NATURAL DRAINWY
10	2	1978-0076	DRNG	C	1/3/1978	1/3/1978	8433 S 124TH ST	723059087	STORM LINE BLKD
12	1	1997-0342	DRNG	C	1/30/1997	3/4/1997	S 8537 124TH ST	723059081	WEEP HOLES THROUGH RETAINING WALL
13	2	1991-1063	FLOODING	C	10/10/1991	10/14/1991	S 8412 124TH ST	1180008175	
13	3	1991-1063	FLOODING	SR	10/10/1991	11/25/1992	S 8412 124TH ST	1180008175	WET YARD/BASEMENT
13	1	1987-1136	DRNG	C	12/4/1987	2/19/1988	S 8412 124TH ST	1180008175	FOUNDATION BUILD OVER DRAIN PIPE
14	1	1994-0872	FUEL/OIL	WQC	11/30/1994	12/5/1994	S 8415 123RD PL	1180008080	ANONYMOUS REPORT COULD NOT CONFIRM
15	1	2001-0348	WQB	WQC	5/31/2001	6/26/2001	12332 85TH AVE S	1180008200	DUMPING OF DRUMS AND LEAKING OILS IN UN-OPENED ROAD RIGHT-OF-WAY
15	2	2001-0348	WQB	WQR	6/26/2001	12/1/1900	12332 85TH AVE S	1180008200	DUMPING OF DRUMS AND LEAKING OILS IN UN-OPENED ROAD RIGHT-OF-WAY
17	1	2007-0522	DDM	C	9/14/2007	9/27/2007	S 8525 123RD PL	1180008235	Flooding/erosion onr prvt rd caused by GW.
22	1	1984-0238	CLEARING	C	7/11/1984	9/21/1984	8210 S 123RD PL	1180007415	
24	1	1997-1468	SPRINGS	C	10/24/1997	10/29/1997	S 8230 123RD PL	1180007375	ACTIVE NDAP-CIP WILL NOT CONS GRND WTR
25	1	1997-1235	DRAINAGE	C	8/8/1997	9/19/1997	S 8236 123RD PL	1180007350	ASPHALT FAILURE ON COUNTY ROAD
26	1	1996-2057	EROSION	C	12/13/1996	6/13/1997	12315 84TH AVE S	1180007300	OHLD SITE VISIT REQUIRED W/ROADS
27	1	1991-0754	DRNG	C	6/17/1991	6/22/1991	S 8411 123RD ST	1180007095	REF KNUDSEN 91-0736/WET BASEMENT
28	1	1993-0767	DRNG	C	8/20/1993	9/9/1993	8432 123RD PLACE SE	1180007105	SEE 93-1133 NDA
29	1	1977-0067	DRNG	C	5/6/1977	5/6/1977	8211 S 123RD ST	1180007230	DVR INTERUPTED/8210 S 123RD PL
30	1	1984-0240	FLDG	C	8/24/1984	8/24/1984	8217 S 123RD ST	1180007245	SLIDE
31	1	1994-0667	DRNG	C	9/13/1994	12/8/1994	S 8241 123RD ST	1180007265	CONVEYANCE THROUGH PVT PROP
31	2	1997-0794	DRAINAGE	C	4/23/1997	6/13/1997	S 8241 123RD ST	1180007265	NEW RES DEVEL IMPACTING DOWNHILL PROP
32	1	1994-0692	CLEARING	E	9/29/1994	12/1/1900	12211 85TH AVE S	1180006650	SPT DDES LAND USE SERV. LEAD AGENT
32	2	1994-0692	CLEARING	C	9/14/1994	9/29/1994	12211 85TH AVE S	1180006650	SPT DDES LAND USE SERV. LEAD AGENT
33	1	1977-0065	DRNG	X	8/2/1977	8/2/1977	8214 S 123RD ST	1180006530	STORM WATER
34	1	2001-0088	DDM	C	2/8/2001	3/21/2001	S 8202 123RD ST	1180006500	REQUEST FOR INFO TO DETERMINE DRAINAGE PATTERN AND POTNETIAL TO ENCLOSE
35	1	1998-0429	DRAINAGE	C	6/23/1998	8/14/1998	S 8254 123RD ST	1180006460	SUBSURFACE FLOW CREATING PONDING
36	1	2002-0024	DDM	C	1/11/2002	3/21/2002	S 8323 122ND ST	1180006445	SURFACEING GROUNDWATER IMPACT TO PRIVATE PROPERTY. IRON OXIDE STAINS EVIDENT
37	1	2002-0761	DES	C	11/18/2002	12/2/2002	8411 S 122ND ST	1180006570	APPARENT NEW DRAINAGE SYSTEM INSTALLATION. ALLEGED OVERFLOW OF CB CREATING SHOULDER EROSION PROBLEM
38	1	2004-0982	REM	FI	7/23/2004	2/14/2005	2320 80TH AVE SE	1180007450	No measurement. No new impervious surfaces.
39	1	2004-0982	REM	FI	7/23/2004	2/14/2005	2320 80TH AVE SE	1180007450	No measurement. No new impervious surfaces.

TABLE - 1
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 001

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
40	1	1983-0398		C	1/11/1983	1/11/1983	12209 82ND AVE S	1180006230	BANK SLIDE UNDERMINING RD
40	2	1986-0435	SLIDE	C	4/23/1986	7/2/1986	12209 82ND AVE S	1180006230	
41	1	2001-0075	DDM	C	1/30/2001	8/1/2001	S 82XX 122ND ST	1180006350	REQUEST FOR DRAINAGE INFORMATION/REVISION SO LOT CAN BE BUILT ON
42	1	1993-0852	DRNG	C	9/20/1993	10/12/1993	S 8207 122ND ST	1180006360	BRYN MAWN
42	2	2006-0094	WQDR	WQC	1/18/2006	2/6/2006	S 8207 122ND ST	1180006360	Worksite dumping dirty water onto street.
42	3	2007-0202	DTA	C	3/21/2007	3/28/2007	S 8207 122ND ST	1180006360	Wants TA for flooding in basement. Inv provided info on channel in backyard & retaining wall issue.
45	1	2003-0305	DDM	C	4/23/2003	5/2/2003	12223 86TH CT S	1180005550	CB GRATE IS BELOW GRADE, POSSIBLY CAUSED BY LOT FILL. DRAINAGE EASEMENT GRANTED TO HOA. CB APPEARS TO BE ON ADJACENT PROPERTY. SYSTEM IS PRIVATELY MAINTAINED.
47	1	1999-0665	DRAINAGE	C	9/14/1999	10/12/1999	12105 87TH AVE S	1180005482	RETAINING WALL CONST CONCERN RE DRAINAG
52	1	1997-0079	DRNG	C	1/6/1997	1/24/1997	12017 84TH AVE S	1180004990	APPARENT STORM EVENT OVERFLOW NO IMPACT
53	2	2004-0654	DDM	C	8/31/2004	9/17/2004	S 8232 122ND ST	1180005890	No lid/grate on CB. Investigation shows CB appears to be abandoned private system. Previously investigated in 99-0113. Provided TA.
54	1	2003-0685	DCA	C	10/20/2003	11/10/2003	S 8231 121ST ST	1180005795	STORM EVENT: WATER IN BASEMENT. APPEARS TO BE EXISTING PROBLEM MADE WORSE BY EXTREME S TORM EVENT
55	1	2006-0731	DTA	C	11/15/2006	12/1/1900	S 8222 122ND ST	1180005900	New construction changing natural flows. Inv found 2 newly constructed houses may be contributing increased flows on to KC ROW. Refer to DDES.
56	1	1989-0159	FLG/HILL	C	3/16/1989	3/26/1989	S 8208 122ND ST	1180005915	HILLSIDE DRAINS INTO SWALE
56	2	1989-0464	DRNG	C	7/13/1989	8/1/1989	S 8208 122ND ST	1180005915	GREENBELT WATER FLOWS TO LOT
56	3	1996-1698	DRNG	C	9/27/1996	10/11/1996	S 8208 122ND ST	1180005915	EXISTING DRAINAGE CHANNEL STABILITY
56	4	1996-1698	DRNG	R	10/11/1996	11/12/1996	S 8208 122ND ST	1180005915	EXISTING DRAINAGE CHANNEL STABILITY
56	5	1997-1381	DRAINAGE	C	9/25/1997	10/8/1997	S 8208 122ND ST	1180005915	LOT CLEARING POTENTIAL DRNG IMP
58	1	1984-0233	DRNG	C	5/20/1984	5/20/1984	8219 S 121ST ST	1180005750	EROSION
58	2	1987-0597	DRNG	C	4/22/1987	6/7/1987	S 8219 121ST ST	1180005750	WATER FLOWS THOUGH LOT
59	1	1997-0471	DRAINAGE	EH	7/3/1997	12/1/1900	12117 82ND AVE S	1180006051	EROSION IN NEWLY CONSTR DRNG CHANNNEL
59	2	1997-0471	DRAINAGE	C	2/21/1997	3/14/1997	12117 82ND AVE S	1180006051	EROSION IN NEWLY CONSTR DRNG CHANNNEL
59	3	1997-0471	DRAINAGE	E	6/11/1997	7/3/1997	12117 82ND AVE S	1180006051	EROSION IN NEWLY CONSTR DRNG CHANNNEL
59	4	1997-0471	DRAINAGE	R	3/14/1997	6/11/1997	12117 82ND AVE S	1180006051	EROSION IN NEWLY CONSTR DRNG CHANNNEL
60	4	1991-0936	DRAINAGE	NDA	8/20/1991	11/19/1992	S 8188 122ND ST	1180006050	PROB CRCTD
60	5	2000-0102	WQD	WQC	2/16/2000	4/19/2000	8118 S 122ND ST	1180006050	NO EVIDENCE OF OIL, TOLD CALLER TO CALL IMMEDIATELY THE NEXT TIME
61	1	1997-1132	WASHINGS	WQR	7/3/1997	7/3/1997	S 8123 121ST ST	1180006030	
62	1	1978-0075	DRNG	C	11/13/1978	11/13/1978	8124 S 121ST ST	1180004785	EROSION/SILT
63	1	1987-0540	DRNG	C	3/23/1987	5/11/1987	S 8115 120TH ST	1180004750	CULVERT PLUGGED 87-0393,0479

TABLE - 2
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 002

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
Source : Adjacent Property/ Development									
7	1	1987-0722	DRAINAGE	C	6/9/1987	7/10/1987	10817 CORNELL AVE S	4058802125	SEE 87-0722 NEIGHBOR WATER
9	1	1994-0922	FLOODING	C	12/20/1994	12/30/1994	11026 PARKVIEW AVE S	4058801185	SHEET FLOW ADJACENT PROPERTY
9	2	1994-0922	FLOODING	RN	12/30/1994	11/3/1995	11026 PARKVIEW AVE S	4058801185	SHEET FLOW ADJACENT PROPERTY
14	1	1996-0302	TRENCH	C	2/9/1996	2/26/1996	10837 AUBURN AVE S	4058801290	NEIGHBORS DRAINING ALLEY ONTO SAUNDERS
14	2	1996-0302	TRENCH	NDA	2/29/1996	11/1/1997	10837 AUBURN AVE S	4058801290	NEIGHBORS DRAINING ALLEY ONTO SAUNDERS
14	3	1996-0302	TRENCH	R	2/26/1996	2/29/1996	10837 AUBURN AVE S	4058801290	NEIGHBORS DRAINING ALLEY ONTO SAUNDERS
19	1	1996-1041	DRAINAGE	C	4/1/1996	6/14/1996	11069 AUBURN AVE S	4058801000	PROPERTY IMPACT FROM ADJ SFR DEV
19	2	1996-1041	DRAINAGE	R	6/14/1996	7/1/1996	11069 AUBURN AVE S	4058801000	PROPERTY IMPACT FROM ADJ SFR DEV
20	1	1996-1041	DRAINAGE	C	4/1/1996	6/14/1996	11069 AUBURN AVE S	4058801000	PROPERTY IMPACT FROM ADJ SFR DEV
20	2	1996-1041	DRAINAGE	R	6/14/1996	7/1/1996	11069 AUBURN AVE S	4058801000	PROPERTY IMPACT FROM ADJ SFR DEV
21	3	1997-0864	DRAINAGE	C	5/6/1997	5/23/1997	10852 ABURN AVE S	4058800815	WATER PONDING SHEET FLOW IMP PVT PROP
22	1	1997-1467	DRAINAGE	C	10/24/1997	11/4/1997	S 7517 LAKERIDGE DR	4058800775	OFFSITE SHEET FLOW IMP TO PVT PROP
22	2	1997-1467	DRAINAGE	NDA	12/3/1997	2/19/1998	S 7517 LAKERIDGE DR	4058800775	OFFSITE SHEET FLOW IMP TO PVT PROP
22	3	1997-1467	DRAINAGE	R	11/4/1997	12/3/1997	S 7517 LAKERIDGE DR	4058800775	OFFSITE SHEET FLOW IMP TO PVT PROP
23	1	1997-0892	DRAINAGE	C	4/23/1997	6/30/1997	S 7535 SUNNYCREST RD	4058800685	SHEET FLOW FROM ADJACENT PROPERTY
24	1	1975-0142	DRAINAGE	C	1/6/1975	1/6/1975	7575 S LAUREL ST	4058800275	& RUNOFF ACROSS LAWN
28	1	1988-0031	DRAINAGE	C	1/19/1988	2/1/1988	7607 SUNNYCREST RD S	4058201420	@ 7630 LAKERIDGE DR/NEW CONSTRUCTION
30	1	1995-0777	DRAINAGE	C	9/18/1995	9/22/1995	S 7676 LAKERIDGE DR	4058201470	ADJ PROPERTY DISCHARGING DS
31	1	1997-1425	EROSION	C	10/8/1997	10/20/1997	S 7615 LAUREL ST	2046200020	CHANNELIZED FLOW FROM ADJACENT PROP
32	2	1998-0905	DRAINAGE	C	12/21/1998	2/5/1999	10445 DIXON DR S	2045800345	EMBANKMENT SLOUGHING IMP PVT PROP
39	1	1987-0705	DRAINAGE	C	5/29/1987	9/8/1987	7911 SUNNYCREST RD S	4058201166	FROM NEIGHBORS/INSTALLED PIPE IN DITCH
40	1	1995-1129	DRAINAGE	X	12/12/1995	1/31/1996	S 7903 LAKE RIDGE DR	4058200715	LINDY WILL MAINTAIN
51	1	1995-1068	RUNOFF	C	12/4/1995	2/2/1996	11011 RAINIER AVE S	1678400085	DRNG FROM ADJACENT LOT
52	1	1995-1068	RUNOFF	C	12/4/1995	2/2/1996	11011 RAINIER AVE S	1678400085	DRNG FROM ADJACENT LOT
Source : Road									
3	1	1995-0502	RDRUNOFF	C	6/6/1995	8/14/1995	10653 CORNELL AVE S	4058801975	SHEET FLOW FROM ROAD OHLDRDCORD
6	1	1987-0717	DRAINAGE	C	6/8/1987	7/10/1987	10800 CRESTWOOD DR S	4058802115	WATER FROM NEIGHBOR NEW SYSTEM 87-0722
8	1	1990-0466	DRAINAGE	C	1/26/1990	3/10/1990	11019 PARKVIEW AVE S	4058802155	WATER FROM ROAD INTO BASEMENT
10	1	1993-1105	DRAINAGE	C	12/20/1993	1/21/1994	11113 CORNELL AVE S	4058801055	GARAGE FLOODS FROM ROADS
11	1	2005-0655	RFN		12/13/2005	1/6/2006	10720 CORNELL AVE S	4058801380	Skyway Water & Sewer I/I. Inv found seepage from pavement in center of road flowing across to edge.
15	1	1996-1981	DRAINAGE	C	12/2/1996	12/24/1996	10849 AUBURN AVE S	4058801280	CONTRIBUTING DRAINAGE IMPACTING ALLEY
17	1	1995-0501	FLOODING	C	6/6/1995	6/19/1995	11027 AUBURN AVE S	4058800970	SHEET FLOW FROM ALLEYWAY
17	2	1995-0501	FLOODING	NDA	1/5/1996	12/13/1996	11027 AUBURN AVE S	4058800970	SHEET FLOW FROM ALLEYWAY
17	3	1995-0501	FLOODING	RN	6/19/1995	1/5/1996	11027 AUBURN AVE S	4058800970	SHEET FLOW FROM ALLEYWAY
17	4	2002-0184	WQI	WQC	3/6/2002	3/8/2002	11017 AUBURN AVE S	4058800960	ROADS MAINT. PROJECT. APPEARS TO BE ILLICIT CONNECTION UPSTREAM IN DRAIANGE SYSTE. INVESTIGATI O CONFIRMED ILLICT GREY WATER CONNECTION
17	5	2002-0184	WQI	WQR	3/8/2002	12/1/1900	11017 AUBURN AVE S	4058800960	ROADS MAINT. PROJECT. APPEARS TO BE ILLICIT CONNECTION UPSTREAM IN DRAIANGE SYSTE. INVESTIGATI O CONFIRMED ILLICT GREY WATER CONNECTION
18	1	1995-0501	FLOODING	C	6/6/1995	6/19/1995	11027 AUBURN AVE S	4058800970	SHEET FLOW FROM ALLEYWAY
18	2	1995-0501	FLOODING	NDA	1/5/1996	12/13/1996	11027 AUBURN AVE S	4058800970	SHEET FLOW FROM ALLEYWAY
18	3	1995-0501	FLOODING	RN	6/19/1995	1/5/1996	11027 AUBURN AVE S	4058800970	SHEET FLOW FROM ALLEYWAY
21	1	1995-0729	RUNOFF	C	9/5/1995	9/22/1995	10852 AUBURN AVE S	4058800815	SHEETFLOW FROM RD AND D/W ACROSS STREET
21	2	1995-0863	FLOODING	C	10/11/1995	11/27/1995	10852 AUBURN AVE S	4058800815	SHEET FLOW FROM RD ONTO PVT PROP
29	1	1996-1287	DITCH	E	9/5/1996	6/9/2005	S 7649 LAKE RIDGE DR	4058201340	SUBSTANDARD CONST IN R/W PAVING & DRNG. 6/9/05 - DOT HAS INSTALLED NEW DRAINAGE ALONG THIS ROAD. PROBLEM NO LONGER EXISTS.
29	2	1996-1287	DITCH	C	6/14/1996	6/9/2005	S 7649 LAKE RIDGE DR	4058201340	SUBSTANDARD CONST IN R/W PAVING & DRNG
29	3	1996-1287	DITCH	R	7/10/1996	6/9/2005	S 7649 LAKE RIDGE DR	4058201340	SUBSTANDARD CONST IN R/W PAVING & DRNG
32	3	2001-0236	DLE	C	4/18/2001	5/11/2001	10445 DIXON DR S	2045800345	SHEET FLOW FROM ROADWAY ONTO PRIVATE PROPERTY. VEGETATION CONTROL ON R/W
36	1	2004-0167	DTA	C	2/1/2004	4/8/2004	S 7714 LAKERIDGE DR	4058200990	Question about CB on property. Investigation found CB on private D/W that appears placed atop 12"CP that crosses prope rty. Could not find ends of pipe. Appears to be private system.
44	1	1997-1455	DRAINAGE	E	12/3/1997	12/1/1900	10837 DIXION DR S	4058200385	SUBSTANDARD CONST IN ROAD R/W
44	2	1997-1455	DRAINAGE	C	10/20/1997	11/4/1997	10837 DIXION DR S	4058200385	SUBSTANDARD CONST IN ROAD R/W
44	3	1997-1455	DRAINAGE	R	11/4/1997	12/3/1997	10837 DIXION DR S	4058200385	SUBSTANDARD CONST IN ROAD R/W

TABLE - 2
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 002

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
45	1	1992-0333	DRAINAGE	C	5/11/1992	5/28/1992	10842 GARDEN PLACE	4058200050	WATER FROM R/W
46	1	2007-0523	RFN	C	9/14/2007	12/1/1900	10875 RAINIER AVE	4058200020	Road runoff down D/W. To Roads.
49	2	1990-0561	EROSION	C	2/6/1990	3/11/1990	11029 84TH AVE S	4058200266	SHOULDER RESTORATION/STORM
50	1	2004-0449	DDM	C	5/26/2004	7/20/2004	11048 84TH AVE S	1678400135	Recent KC roads project causes drainage problem. KC Roads aware and designing fix.
51	2	1997-0904	FLOODING	C	4/23/1997	6/30/1997	11011 RAINIER AVE S	1678400085	ALLEGED PROPERTY DAMAGE FROM SHEET FLOW
52	2	1997-0904	FLOODING	C	4/23/1997	6/30/1997	11011 RAINIER AVE S	1678400085	ALLEGED PROPERTY DAMAGE FROM SHEET FLOW
53	1	1998-0880	FLOODING	NDA	6/1/1999	12/1/1900	11015 RAINIER AVE S	1678400075	OFFSITE FLOW SHEET AND CONCENTRATED
53	2	1998-0880	FLOODING	C	12/11/1998	1/8/1999	11015 RAINIER AVE S	1678400075	OFFSITE FLOW SHEET AND CONCENTRATED
53	3	1998-0880	FLOODING	R	1/8/1999	6/1/1999	11015 RAINIER AVE S	1678400075	OFFSITE FLOW SHEET AND CONCENTRATED
54	1	1998-0880	FLOODING	NDA	6/1/1999	12/1/1900	11015 RAINIER AVE S	1678400075	OFFSITE FLOW SHEET AND CONCENTRATED
54	2	1998-0880	FLOODING	C	12/11/1998	1/8/1999	11015 RAINIER AVE S	1678400075	OFFSITE FLOW SHEET AND CONCENTRATED
54	3	1998-0880	FLOODING	R	1/8/1999	6/1/1999	11015 RAINIER AVE S	1678400075	OFFSITE FLOW SHEET AND CONCENTRATED
55	1	1995-0680	RUNOFF	C	8/17/1995	8/24/1995	8418S 112TH ST	623059007	SHEETFLOW FROM RD UNDER HOUSE
55	2	1995-0680	RUNOFF	NDA	12/12/1995	5/20/1996	8418S 112TH ST	623059007	SHEETFLOW FROM RD UNDER HOUSE
55	3	1995-0680	RUNOFF	RN	8/24/1995	12/12/1995	8418S 112TH ST	623059007	SHEETFLOW FROM RD UNDER HOUSE
56	3	1990-1500	EROSION	C	11/21/1990	12/15/1990	S 8046 114TH ST	3810000104	ROAD WATER FLOWING INTO DRIVEWAY
56	4	1993-0978	DRAINAGE	C	11/5/1993	12/28/1993	S 8046 114TH ST	3810000104	ROADS COORDINATION
56	5	1993-0978	DRAINAGE	NDA	6/26/1995	6/12/1996	S 8046 114TH ST	3810000104	WATER DOWN DRIVEWAYS
56	6	1993-0978	DRAINAGE	RN	2/1/1994	6/26/1995	S 8046 114TH ST	3810000104	WATER DOWN DRIVEWAYS
57	3	1988-0693	FLOODING	C	11/3/1988	11/4/1988	S 8042 114TH ST	3810000103	SEE 88-0473 HARGILL/WATER FROM ROAD
57	4	1989-0195	DRAINAGE	C	3/28/1989	5/5/1989	S 8042 114TH ST	3810000103	WATER FLOODING DRWY AND GARAGE
57	5	1990-1500	EROSION	C	11/21/1990	12/15/1990	S 8046 114TH ST	3810000104	ROAD WATER FLOWING INTO DRIVEWAY
57	6	1993-0978	DRAINAGE	C	11/5/1993	12/28/1993	S 8046 114TH ST	3810000104	ROADS COORDINATION
57	7	1993-0978	DRAINAGE	NDA	6/26/1995	6/12/1996	S 8046 114TH ST	3810000104	WATER DOWN DRIVEWAYS
57	8	1993-0978	DRAINAGE	RN	2/1/1994	6/26/1995	S 8046 114TH ST	3810000104	WATER DOWN DRIVEWAYS
57	11	2004-0542	DDM	R	6/29/2004	9/16/2004	S 8042 114TH ST	3810000103	RUNOFF FROM ROAD SHOULDER FLOWS DOWN DRIVEWAY.
59	1	1995-0680	RUNOFF	C	8/17/1995	8/24/1995	8418S 112TH ST	623059007	SHEETFLOW FROM RD UNDER HOUSE
59	2	1995-0680	RUNOFF	NDA	12/12/1995	5/20/1996	8418S 112TH ST	623059007	SHEETFLOW FROM RD UNDER HOUSE
59	3	1995-0680	RUNOFF	RN	8/24/1995	12/12/1995	8418S 112TH ST	623059007	SHEETFLOW FROM RD UNDER HOUSE
60	1	2002-0523	DCA	C	7/17/2002	3/8/2004	11109 RAINIER AVE S	623059020	ASPHALT PATCH ALONG CURB LAYED TO HIGH. BLOCKING FLOW
61	1	1997-0396	RD DRNG	C	2/6/1997	3/12/1997	10615 RUSTIC RD S	4058801895	SHEET FLOW FROM ROAD OVERTOPS A/C BERM
Source : Downspout									
42	1	1990-0764	DRAINAGE	NDA	3/16/1990	12/1/1900	10811 DIXON DR S	4058200400	DOWNSPOUTS
42	2	1990-0764	DRAINAGE	C	3/16/1990	3/27/1990	10811 DIXON DR S	4058200400	DOWNSPOUT DRNG
43	1	1990-0764	DRAINAGE	NDA	3/16/1990	12/1/1900	10811 DIXON DR S	4058200400	DOWNSPOUTS
43	2	1990-0764	DRAINAGE	C	3/16/1990	3/27/1990	10811 DIXON DR S	4058200400	DOWNSPOUT DRNG
52	3	2002-0218	DDM	C	3/15/2002	2/4/2003	11013 RAINIER AVE S	1678400080	APPARENT DISCHARGE OF DOWNSPOUTS/FOOTING DRAINS OVER SIDEWALK. PREVIOUS NDAP CONSTRUCTED STUB-OUT
52	4	2002-0218	DDM	R	5/6/2002	2/4/2003	11013 RAINIER AVE S	1678400080	APPARENT DISCHARGE OF DOWNSPOUTS/FOOTING DRAINS OVER SIDEWALK. PREVIOUS NDAP CONSTRUCTED STUB-OUT
52	5	2002-0218	DDM	NDA-Q	10/21/2002	2/4/2003	11013 RAINIER AVE S	1678400080	APPARENT DISCHARGE OF DOWNSPOUTS/FOOTING DRAINS OVER SIDEWALK. PREVIOUS NDAP CONSTRUCTED STUB-OUT
53	4	2002-0218	DDM	C	3/15/2002	2/4/2003	11013 RAINIER AVE S	1678400080	APPARENT DISCHARGE OF DOWNSPOUTS/FOOTING DRAINS OVER SIDEWALK. PREVIOUS NDAP CONSTRUCTED STUB-OUT
53	5	2002-0218	DDM	R	5/6/2002	2/4/2003	11013 RAINIER AVE S	1678400080	APPARENT DISCHARGE OF DOWNSPOUTS/FOOTING DRAINS OVER SIDEWALK. PREVIOUS NDAP CONSTRUCTED STUB-OUT
53	6	2002-0218	DDM	NDA-Q	10/21/2002	2/4/2003	11013 RAINIER AVE S	1678400080	APPARENT DISCHARGE OF DOWNSPOUTS/FOOTING DRAINS OVER SIDEWALK. PREVIOUS NDAP CONSTRUCTED STUB-OUT
Source : Broken/Inadequate Drainage System									
56	1	1988-0473	DRAINAGE	C	6/30/1988	8/10/1988	S 8046 114TH ST	3810000104	INADEQUATE DRNG SYSTEM
56	2	1988-0473	DRAINAGE	ER	8/10/1988	2/28/1989	S 8046 114TH ST	3810000104	NEIGHBORS TAPPED INTO DRAIN LINE
57	1	1988-0473	DRAINAGE	C	6/30/1988	8/10/1988	S 8046 114TH ST	3810000104	INADEQUATE DRNG SYSTEM
57	2	1988-0473	DRAINAGE	ER	8/10/1988	2/28/1989	S 8046 114TH ST	3810000104	NEIGHBORS TAPPED INTO DRAIN LINE
57	10	1997-0947	PIPE	C	5/15/1997	7/18/1997	S 8042 114TH ST	3810000103	NATURAL OBSTRUCT OF EXIST DRNG CHANNEL

TABLE - 2
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 002

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
Source : Groundwater									
26	1	2005-0185	DTA	C	4/4/2005	4/14/2005	10604 WOODLEY AVE S	4058800176	Wet backyard, not from water district. Investigation could not find any source of surface runoff. Appears to be groundwater. Provided contractor list.
27	3	2005-0272	DDM	C	5/16/2005	6/7/2005	S 7603 SUNNYCREST RD	4058800170	Ponding in backyard. Not from water/sewer district. See also 2005-0185. Investigation found apparent groundwater problem. Possibly from recent sanitary sewer work? No impact from/to KC drainage facilities.
37	1	1998-0039	DRAINAGE	C	1/19/1998	2/13/1998	10818 FOREST AVE S	7553800015	APPARENT GROUND WATER IMP PVT PROP
37	2	2002-0372	DDM	C	5/14/2002	6/20/2002	10818 FOREST AVE S	7553800015	APPARENT GROUNDWATER IMPACT TO BASEMENT. COMPLAINANT HAD SUMP PUMP INSTALLED. APPARENTLY DID NOT CORRECT PROB.
Source : Other Complaints									
1	1	1982-0536	EROSION	C	2/16/1982	2/16/1982	10637 RUSTIC RD S	4058801915	
2	1	2006-0645	RVC	C	10/11/2006	10/24/2006	& LAKE RIDGE DR S RUSTIC RD S	4058802290	Portion of Lake Ridge Dr S, west of Rustic Rd S. No WLRD impact.
4	1	1996-0930	EROSION	CL	4/19/1996	9/5/1996	S 7100 SUNNYCREST DR	4058801595	
5	1	1996-0828	EROSION	CL	3/1/1996	9/5/1996	S 7112 SUNNYCREST RD	4058801590	
6	2	2006-0414	WQDR	WQC	5/25/2006	6/26/2006	& SE CRN OF CORNELL CRESTWOOD DR SE	4058802115	Washing paint equipment into stormdrain. Education provided.
9	3	1995-0544	DUMPING	WQC	6/19/1995	7/12/1995	11026 PARKVIEW AVE S	4058801185	INFO LETTER RE. YARD WASTE 7/10/95
12	1	1994-0180	DRAINAGE	C	3/8/1994	3/30/1994	10802 CORNELL AVE S	4058801200	PONDING IN ROADSIDE DITCH
13	1	2004-0376	MMF	C	4/16/2004	5/1/2004	10825 AUBURN AVE S	4058801300	Storm system backs up during heavy rains. NDAP 96-0302 installed adjacent to property. Downstream KC Roads system needs maintenance.
16	1	2002-0783	DTA	R	12/10/2002	12/23/2002	10859 AUBURN AVE S	4058801270	SUPPORT TO THE I&I PROGRAM
19	3	1997-0671	MUD MESS	C	3/26/1997	4/4/1997	11065 AUBURN AVE S	4058800995	DITCHING CREWS LEFT MESS
24	2	1997-0891	FLOODING	C	4/23/1997	6/30/1997	S 7575 LAUREL ST	4058800275	PVT LOT DRAINAGE PIPE REPAIR REQU
25	1	2004-0192	WQI	WQC	3/3/2004	3/19/2004	10631 FOREST AVE S	4058800220	Diesel smell from drainage system? Investigation indicates possible heating oil getting into drainage.
25	2	2004-0192	WQI	WQR	3/19/2004	12/1/1900	10631 FOREST AVE S	4058800220	Diesel smell from drainage system? Investigation indicates possible heating oil getting into drainage.
27	2	2000-0420	WQD	WQC	6/7/2000	3/7/2004	S 7603 SUNNYCREST DR	4058800170	APPARENT LEAKING HEATING OIL TANK. OIL SURFACING ALONG ROAD SHOULDER
28	1	2000-0420	WQD	WQR	6/16/2000	3/7/2004	S 7603 SUNNYCREST DR	4058800170	APPARENT LEAKING HEATING OIL TANK. OIL SURFACING ALONG ROAD SHOULDERRESIDENT CONTACTED, OIL COMPANY CONTACTED TESTS COMPLETED TANK NOT LEAKING SMALL SPILL OCCURRED DOE WILL FINISH
32	1	1997-0905	FLOODING	R	4/23/1997	4/18/2001	10445 DIXON DR S	2045800345	WEST HILL - SEE NEW COMPLAINT CONCERNING STABILITY OF HILLSIDE BEHIND HOUSE.
33	1	2003-0302	DTA	C	4/21/2003	5/19/2003	10735 FOREST AVE S	7553800051	APPARENT LOT DRAIANGE DISCHARGE IMPACT COMPLAINANT'S PROPERTY. PROVIDED TECHNICAL ASSISTANCE
34	1	2005-0077	RFN	C	2/3/2005	2/15/2005	10732 FOREST AVE S	7553800035	Broken culvert eroding property. Investigation found downstream end section of 12" conc culvert under KC Road has come loose.
35	1	1996-1592	RUNOFF	C	9/5/1996	9/27/1996	S 7701 SUNNYCREST RD	4058201005	RET.WALL IN ROW RDS RUNOFF PROB
38	1	1990-1585	FLOODING	E	1/8/1991	12/1/1900	10625 DIXON DR. S	2045800260	STORM EVENT/CHKSTATBYCMDT
38	2	1990-1585	FLOODING	C	12/4/1990	1/8/1991	10625 DIXON DR S	2045800260	PAVED OVER DITCH/FLDG GARAGE
41	1	2000-0088	WQD	WQC	2/9/2000	4/19/2000	10653 DIXON DR S	2045800225	NO EVIDENCE OF OIL, TOLD CALLER TO CALL IMMEDIATELY THE NEXT TIME
41	2	2001-0538	WQO	WQC	9/10/2001	10/24/2001	10653 DIXON DR S	2045800225	NO CONTAMINATION IDENTIFIED. PROBABLE EXISTANCE OF IRON OXIDE. INFO PROVIDED
42	1	1997-0963	MOSQUITO	C	5/19/1997	6/6/1997	S 8038 114TH ST	3810000102	POND ON ACTIVE DEVELOPMENT PROJECT
42	3	1990-0810	DITCH	C	3/27/1990	4/17/1990	10807 DIXON DR S	4058200405	IMPROPERLY OUTLETTING/90-0764
47	1	2005-0338	WQB	WQC	6/23/2005	7/25/2005	& RAINIER AVES S LAKERIDGE DR	4058200165	Clearing/landscaping with no BMPs. Investigator gave info
48	1	1983-0399	FLOODING	C	12/29/1983	12/29/1983	10923 RAINIER AVE S	4058200145	DRAIN PIPE
49	3	1993-0324	DTY H2O	C	9/14/1993	10/4/1993	11029 84TH AVE S	4058200266	CATCH BASIN
49	1	1989-0398	DRAINAGE	C	6/12/1989	7/31/1989	11029 84TH AVE S	4058200266	WANTS TO START FILLING LOT
49	4	1993-0324	DTY H2O	WQC	4/28/1993	9/14/1993	11029 84TH AVE S	4058200266	TURNED TO C
49	5	1993-0873	EROSION	NDA	9/23/1994	9/23/1994	11029 84TH AVE S	4058200266	EROSION
49	6	1993-0873	EROSION	RN	5/26/1993	9/23/1994	11029 84TH AVE S	4058200266	EROSION
50	2	2005-0534	DDM	C	10/3/2005	12/1/1900	11048 84TH AVE S	1678400135	New CB not draining. Inv found CB insert needs maint. Current on-going road project. Refer to Rd Insp.
55	4	2004-0173	DTA	C	2/1/2004	4/29/2004	S 8505 110TH CT	1678400110	Property owner wants previous NDA project extended to help solve flooding. Tim Kelly working as Coles-Lakeview Phase 2 project.
56	7	1995-0546	RDRUNOFF	C	6/20/1995	9/27/1995	S 8046 114TH ST	3810000104	POSSIBLE NDA PROJECT SEE 93-0978
57	9	1995-0546	RDRUNOFF	C	6/20/1995	9/27/1995	S 8046 114TH ST	3810000104	POSSIBLE NDA PROJECT SEE 93-0978
60	2	2004-0541	WQDR	WQC	7/15/2004	8/18/2004	11109 RAINIER AVE S	623059020	DOE referral regarding oil dumped into storm system. No significant oil found.
62	1	1996-1232	CULVERT	CL	6/6/1996	9/23/1996	10611 RUSTIC RD S	4058801890	BLOCKED CULVERT

TABLE - 3
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 003

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
Source : Adjacent Property/ Development									
6	1	1987-0635	DRNG	C	5/5/1987	6/28/1987	S 7604 120TH ST	3810000660	NEIGHBORS WATER
20	1	1991-0419	DRNG	C	3/22/1991	4/6/1991	11623 82ND AVE S	3810000455	NEIGHBORS WATER
26	1	1987-1188	DRNG	C	12/18/1987	6/12/1988	11507 84TH AVE S	3810000320	NEW CONST DRNG 87-1166
27	1	1987-1166	DRNG	C	12/11/1987	4/20/1988	11503 84TH AVE S	3810000350	NEW CONST FLOODING HIM
27	2	1987-1188	DRNG	C	12/18/1987	6/12/1988	11507 84TH AVE S	3810000320	NEW CONST DRNG 87-1166
28	1	1997-0592	DRAINAGE	C	3/19/1997	4/18/1997	11437 82ND PL S	8664900090	CURRENT DEVELOPMENT IN PROGRESS
31	2	1986-1260	DRNG	C	12/7/1986	3/4/1987	S 8048 116TH ST	3810000203	NEIGHBORS WATER
31	3	1989-0125	DRNG	C	3/10/1989	3/26/1989	S 8048 116TH ST	3810000203	(FM CHURCH)PARKING LOT DISCHARGE
Source : Road									
4	1	1996-0056	RUNOFF	C	1/17/1996	4/24/1996	12014 80TH AVE S	1180004880	SHEETFLOW FROM ROAD IMP PVT PROP
7	1	1996-1128	FLDG	C	5/15/1996	6/28/1996	11836 76TH AVE S	6706300050	OFFSITE FLOW IMPACTING PVT PROP
7	2	1996-1128	FLDG	NDA	10/3/1996	10/3/1996	11836 76TH AVE S	6706300050	OFFSITE FLOW IMPACTING PVT PROP
7	3	1996-1128	FLDG	R	6/28/1996	10/3/1996	11836 76TH AVE S	6706300050	OFFSITE FLOW IMPACTING PVT PROP
9	1	1997-0889	WESTHILL	C	4/23/1997	7/3/1997	11821 78TH AVE S	6706200050	FLOW FROM ROAD BYPASSING CATCH BASIN
19	1	1982-0530	DRNG	C	3/17/1982	3/17/1982	8019 S 116TH ST	3810000522	FROM RD
23	1	1997-0178	FLDG	C	1/2/1997	1/30/1997	S 8237 116TH ST	3810000425	SHEET FLOW FROM ROAD IMPACTING PVT PROP
24	1	1997-0179	FLDG	C	1/2/1997	1/30/1997	11603 84TH AVE S	3810000360	SHEET FLOW FROM ROAD IMPACT PVT PROP
25	1	1997-0078	FLDG	C	1/5/1997	1/30/1997	S 8240 116TH ST	3810000340	SHEET FLOW FROM ROAD IMP PVT PROP
30	1	1997-0076	FLDG	C	1/2/1997	3/7/1997	S 8220 114TH ST	3810000100	SHEET FLOW FROM ROAD IMPACT PVT PROP
31	1	1998-0822	FLOODING	NDA	11/8/1999	12/20/1999	S 8048 116TH ST	3810000203	OFFSITE FLOW FROM UPBASIN IMP PVT PROP
31	4	1998-0822	FLOODING	R	12/4/1998	11/8/1999	S 8048 116TH ST	3810000203	OFFSITE FLOW FROM UPBASIN IMP PVT PROP
32	1	2000-0474	DDM	C	6/27/2000	8/4/2000	12204 80TH AVE S	1180006150	OUTLET FROM ROAD DRAINAGE SYSTEM APPEARS TO BE COVERED OR PLUGGED
Source : Broken/Inadequate Drainage System									
21	1	1977-0066	DRNG	C	9/12/1977	9/12/1977	11612 82ND AVE S	3810400011	BLKD NATURAL DRNG
21	2	1977-0068	DRNG	C	9/9/1977	9/9/1977	11612 82ND AVE S	3810400011	RUNOFF/BLKAGE
Source : Groundwater									
15	1	2006-0187	MMF	C	2/13/2006	2/23/2006	S 7906 116TH ST	9282801010	Flooding in backyard & house. Apprears to be groundwater seepage. TA provided.
17	3	1997-1051	DRAINAGE	C	5/20/1997	9/17/1997	11545 80TH AVE S	9282801045	GROUNDWATER IMPACT TO PVT PROP
Source : Other Complaints									
1	1	2001-0833	WQP	WQP	12/18/2001	12/19/2001	12320 80TH AVE S	7657000625	2 catch basins both very cleanno dumping dumpsters closedarea well maintained Newly remodeled school
2	1	2004-0982	REM	FI	7/23/2004	2/14/2005	2320 80TH AVE SE	1180007450	No measurement. No new impervious surfaces.
3	2	2001-0721	DDM	C	11/16/2001	12/2/2001	12204 80TH AVE S	1180006150	STORM EVENT: APPARENT OVERFLOW FROM CATCH BASIN IN R/W. RESULT IS EROSION OF SLOPE
5	1	2004-0529	DTA	C	7/12/2004	7/27/2004	11850 78TH AVE S	3810000800	Deep open ditch along KC road in front of complainant property. Safety issue for schoolchilden? Possible to tightline?
8	1	1997-1121	DRAINAGE	C	6/30/1997	7/1/1997	11814 77TH AVE S	6706200130	BACKYARD DRAINAGE SWALE SEDIMENT IMP
10	1	2002-0366	DDM	C	5/8/2002	5/20/2002	11824 78TH AVE S	3991400020	REQUEST TO ENCLOSE R/S DITCH. OWNERS ARE ELDERLY AND CONCERNED ABOUT FALLING IN DITCH
11	1	2001-0587	DDM	C	9/27/2001	10/11/2001	11804 79TH AVE S	3991400045	REQUEST FOR TA. DRAINAGE INSTALLATION FOR OFFSITE FLOW. POSSIBLE DOWNSTREAM IMPACT FRO M HISTORIC DRAINAGE
11	2	2001-0587	DDM	R	10/11/2001	12/1/1900	11804 79TH AVE S	3991400045	REQUEST FOR TA. DRAINAGE INSTALLATION FOR OFFSITE FLOW. POSSIBLE DOWNSTREAM IMPACT FRO M HISTORIC DRAINAGE
12	1	2000-0589	WQB	WQC	8/24/2000	9/25/2006	S 7722 117TH	9124600040	CONCRETE SLURRY WASHED INTO STORM DRAINAGE SYSTEM. CONTACTED VIOLATOR REQUIRED CLEAN ING
12	2	2000-0589	WQB	WQR	8/29/2000	9/25/2006	S 7722 117TH	9124600040	CONCRETE SLURRY WASHED INTO STORM DRAINAGE SYSTEM. CONTACTED VIOLATOR REQUIRED CLEAN ING
12	3	1990-0574	CHNL CHG	C	2/5/1990	2/24/1990	404 W GRIFFITH CK NE	9124600035	STORM DEBRIS CAUSE CHANNEL CHANGE

TABLE - 3
DRAINAGE COMPLAINTS FOR SKYWAY MINI BASIN BLS 003

Map Number	Rec	Complaint No	Problem	Type	Recd Date	Close Date	Address	PIN	Comments
13	1	2000-0589	WQB	WQC	8/24/2000	9/25/2006	S 7722 117TH	9124600040	CONCRETE SLURRY WASHED INTO STORM DRAINAGE SYSTEM. CONTACTED VIOLATOR REQUIRED CLEAN ING
13	2	2000-0589	WQB	WQR	8/29/2000	9/25/2006	S 7722 117TH	9124600040	CONCRETE SLURRY WASHED INTO STORM DRAINAGE SYSTEM. CONTACTED VIOLATOR REQUIRED CLEAN ING
14	1	1997-1358	TA	C	9/18/1997	9/30/1997	S 7648 116TH ST	9282800930	LOT DRNG D/S DISC LOCATION
16	1	1986-0640	FLDG	C	6/23/1986	11/3/1986	S 7918 116TH ST	9282801030	IN BASEMENT
17	1	1986-01C0	FLDG	C	1/18/1986	5/5/1986	11545 80TH AVE S	9282801045	CL#9807 86-0508,0149
17	2	1986-01C0	FLDG	CL	5/5/1986	5/27/1987	11545 80TH AVE S	9282801045	CLAIM #9807
18	1	2006-0221	MMF	C	2/9/2006	3/3/2006	S 80TH AVE & S 117TH ST	3810000500	Creek flowing out of ditch & onto road. Appears to be blockage in ditch adjacent to paved portion of ROW. KC Roads al ready aware.
21	3	1979-0097	FLDG	C	2/26/1979	2/26/1979	11612 82ND AVE S	3810400011	CRAWL SPACE/BRYN MAWR
22	1	2006-0248	WQAI	WQA	3/6/2006	12/1/1900	11619 84TH AVE S	3810000400	
29	1	1982-0526	FLDG	C	12/23/1982	12/23/1982	8209 S 114TH ST	3810000236	TOWNSEND ADDRESS
32	1	2001-0777	DDM	R	11/27/2001	1/12/2002	11431 81ST PL S	1180500070	RELATED TO 98-0822.
33	1	1996-0090	GRADING	C	1/22/1996	2/29/1996	S 114TH ST & 80TH S	3810000150	APPARENT PRELIM PLAT WORK PRIOR TO APP

King County

Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report

APPENDIX C.
SELECTED ALTERNATIVE SPREADSHEETS

April 2009

Alternative BLS-E

Basin:	BLS 003
Date:	7/20/2008
Scenario:	BLS003E
Scenario Description:	Rehabilitation of properties downstream of Meter BLS003A; in northeast section of mini-basin

Summary of I/I Removal - Cost Estimates

Description	Quantity	Unit	Unit Cost	Total Cost
Mains - Pipe Burst (easy)	0	LF	$ 134	$ -
Mains - Pipe Burst (difficult)	0	LF	$ 314	$ -
Mains - Pipe Lining (easy)	0	LF	$ -	$ -
Mains - Pipe Lining (difficult)	0	LF	$ -	$ -
Mains - Open Cut Replacement (easy)	0	LF	$ -	$ -
Mains - Open Cut Replacement (difficult)	0	LF	$ -	$ -
Manhole Replacement (easy)	0	EA	$ -	$ -
Manhole Replacement (difficult)	0	EA	$ -	$ -
Lateral Pipe Bursting (easy)	0	EA	$ -	$ -
Lateral Pipe Bursting (medium)	0	EA	$ -	$ -
Lateral Pipe Bursting (difficult)	0	EA	$ -	$ -
Lateral Lining (easy)	0	EA	$ -	$ -
Lateral Lining (medium)	0	EA	$ -	$ -
Lateral Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral Replacement (difficult)	0	EA	$ -	$ -
Side Sewer Pipe Bursting (easy)	0	EA	$ 3,310	$ -
Side Sewer Pipe Bursting (medium)	0	EA	$ 5,380	$ -
Side Sewer Pipe Bursting (difficult)	0	EA	$ 6,600	$ -
Side Sewer Lining (easy)	0	EA	$ -	$ -
Side Sewer Lining (medium)	0	EA	$ -	$ -
Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Lateral/Side Sewer Pipe Bursting (easy)	50	EA	$ 7,295	$ 364,750
Lateral/Side Sewer Pipe Bursting (medium)	13	EA	$ 8,515	$ 110,695
Lateral/Side Sewer Pipe Bursting (difficult)	2	EA	$ 11,220	$ 22,440
Lateral/Side Sewer Lining (easy)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (medium)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Direct Disconnects	8	EA	$ 3,000	$ 24,000
			Subtotal	$ 521,885
			Sales Tax 9.0%	$ 46,970
			Construction Subtotal	$ 568,855
			Allied Cost 53.0%	$ 301,493
			Project Cost	$ 870,348
			Contingency 30.0%	$ 261,104
			Total Estimated Project Cost (2007 Dollars)	**$ 1,131,000**

Estimated Construction Cost Including Contingency

Construction Subtotal Incl. Sales Tax	$ 568,855
Contingency 30.0%	$ 170,656
Total Estimated Construction Cost (2007 Dollars)	**$ 739,500**

Summary of I/I Removal - I/I Reduction

Description	Source	Quantity	Units
General			
Projected 20-year I/I	King County	1.68	MGD
Assumed inflow estimate	Estimated	0.061	MGD
Remaining Basin I/I, (I/I minus inflow)		1.62	MGD
Acres	King County	63.36	ac
I/I per acre		25,556	gpad
Number of properties		232	
Total Quantities in Basin			
Total length of mainlines	CCTV Inspection	13,212	LF
Total number of laterals	Assume one lateral per property.	232	
Total number of side sewers	Assume one side sewer per lateral.	232	
Total number of lateral/side sewers	Assume one side sewer per lateral.	232	
Total number of manholes	GIS		
Total number of direct disconnects	Smoke test results	8	
Total Quantities in Basin - Rehabilitated			
Total length of mainlines - rehabilitated		0	LF
Total number of laterals - rehabilitated		0	
Total number of side sewers - rehabilitated		0	
Total number of lateral/side sewers - rehabilitated		65	
Total number of manholes - rehabilitated		0	
Total number of performed disconnections		8	
Percent Rehabilitated in Basin			
Mainlines rehabilitated		0%	
Laterals rehabilitated		0%	
Side sewers rehabilitated		0%	
Lateral/side sewers rehabilitated		28%	
Manholes rehabilitated		0%	
Performed disconnections		100%	
I/I Allocation in Basin (Private Properties)			
Percentage of private properties in basin over which I/I (I/I minus inflow) is to be apportioned	Assumed.	90%	
I/I allocation per property (no degradation)		5	gpm
Number of properties to be rehabilitated		65	
Private property estimated I/I reduction assuming 60% reduction (no degradation)		0.30	MGD
Private property estimated I/I reduction assuming 75% reduction (no degradation)		0.38	MGD
I/I Removal in Basin			
I/I removal due to performed disconnections (100% reduction assumed)		0.06	MGD
I/I removal due to private property rehabilitations (60% I/I reduction assumed per fixed property)		0.30	MGD
I/I removal due to private property rehabilitations (75% reduction assumed per fixed property)		0.38	MGD
Summary: I/I Removal (60% I/I Reduction Assumed for Private Properties; No Degradation)			
Total I/I Removal		0.36	MGD
Minimum Remaining I/I		1.3	MGD
Minimum Remaining I/I		20,783	gpad
Summary: I/I Removal (75% I/I Reduction Assumed for Private Properties; No Degradation)			
Total I/I Removal		0.44	MGD
Minimum Remaining I/I		1.2	MGD
Minimum Remaining I/I		19,589	gpad

Alternative BLS-E

Basin:	BLS 002
Date:	7/20/2008
Scenario:	BLS002E
Scenario Description:	Rehabilitation of easy properties in BLS002 that together with Scenario BLS003E provides a minimum of 1.81 mgd removal at 60% removal efficiency

Summary of I/I Removal - Cost Estimates

Description	Quantity	Unit	Unit Cost	Total Cost
Mains - Pipe Burst (easy)	0	LF	$ 134	$ -
Mains - Pipe Burst (difficult)	0	LF	$ 314	$ -
Mains - Pipe Lining (easy)	0	LF	$ -	$ -
Mains - Pipe Lining (difficult)	0	LF	$ -	$ -
Mains - Open Cut Replacement (easy)	0	LF	$ -	$ -
Mains - Open Cut Replacement (difficult)	0	LF	$ -	$ -
Manhole Replacement (easy)	0	EA	$ -	$ -
Manhole Replacement (difficult)	0	EA	$ -	$ -
Lateral Pipe Bursting (easy)	0	EA	$ -	$ -
Lateral Pipe Bursting (medium)	0	EA	$ -	$ -
Lateral Pipe Bursting (difficult)	0	EA	$ -	$ -
Lateral Lining (easy)	0	EA	$ -	$ -
Lateral Lining (medium)	0	EA	$ -	$ -
Lateral Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral Replacement (difficult)	0	EA	$ -	$ -
Side Sewer Pipe Bursting (easy)	0	EA	$ 3,310	$ -
Side Sewer Pipe Bursting (medium)	0	EA	$ 5,380	$ -
Side Sewer Pipe Bursting (difficult)	0	EA	$ 6,600	$ -
Side Sewer Lining (easy)	0	EA	$ -	$ -
Side Sewer Lining (medium)	0	EA	$ -	$ -
Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Lateral/Side Sewer Pipe Bursting (easy)	270	EA	$ 7,295	$ 1,969,650
Lateral/Side Sewer Pipe Bursting (medium)	0	EA	$ 8,515	$ -
Lateral/Side Sewer Pipe Bursting (difficult)	0	EA	$ 11,220	$ -
Lateral/Side Sewer Lining (easy)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (medium)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Direct Disconnects	10	EA	$ 3,000	$ 30,000
			Subtotal	$ 1,999,650
			Sales Tax 9.0%	$ 179,969
			Construction Subtotal	$ 2,179,619
			Allied Cost 53.0%	$ 1,155,198
			Project Cost	$ 3,334,816
			Contingency 30.0%	$ 1,000,445
			Total Estimated Project Cost (2007 Dollars)	**$ 4,335,000**

Estimated Construction Cost Including Contingency

Construction Subtotal Incl. Sales Tax		$ 2,179,619
Contingency	30.0%	$ 653,886
Total Estimated Construction Cost (2007 Dollars)		**$ 2,833,500**

Summary of I/I Removal - I/I Reduction

Description	Source	Quantity	Units
General			
Projected 20-year I/I	King County	3	MGD
Assumed inflow estimate	Estimated	0.112	MGD
Remaining Basin I/I, (I/I minus inflow)		2.89	MGD
Acres	King County	109	ac
I/I per acre		26,494	gpad
Number of properties		386	
Total Quantities in Basin			
Total length of mainlines	CCTV Inspection	0	LF
Total number of laterals	Assume one lateral per property.	386	
Total number of side sewers	Assume one side sewer per lateral.	386	
Total number of lateral/side sewers	Assume one side sewer per lateral.	386	
Total number of manholes	GIS		
Total number of direct disconnects	Smoke test results	10	
Total Quantities in Basin - Rehabilitated			
Total length of mainlines - rehabilitated		0	LF
Total number of laterals - rehabilitated		0	
Total number of side sewers - rehabilitated		0	
Total number of lateral/side sewers - rehabilitated		270	
Total number of manholes - rehabilitated		0	
Total number of performed disconnections		10	
Percent Rehabilitated in Basin			
Mainlines rehabilitated		0%	
Laterals rehabilitated		0%	
Side sewers rehabilitated		0%	
Lateral/side sewers rehabilitated		70%	
Manholes rehabilitated		0%	
Performed disconnections		100%	
I/I Allocation in Basin (Private Properties)			
Percentage of private properties in basin over which I/I (I/I minus inflow) is to be apportioned	Assumed.	90%	
I/I allocation per property (no degradation)		5.8	gpm
Number of properties to be rehabilitated		270	
Private property estimated I/I reduction assuming 60% reduction (no degradation)		1.35	MGD
Private property estimated I/I reduction assuming 75% reduction (no degradation)		1.68	MGD
I/I Removal in Basin			
I/I removal due to performed disconnections (100% reduction assumed)		0.11	MGD
I/I removal due to private property rehabilitations (60% I/I reduction assumed per fixed property)		1.35	MGD
I/I removal due to private property rehabilitations (75% reduction assumed per fixed property)		1.68	MGD
Summary: I/I Removal (60% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	1.46	MGD
	Minimum Remaining I/I	1.5	MGD
	Minimum Remaining I/I	14,139	gpad
Summary: I/I Removal (75% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	1.80	MGD
	Minimum Remaining I/I	1.2	MGD
	Minimum Remaining I/I	11,051	gpad

Alternative BLS-F

Basin:	BLS 002
Date:	7/24/2008
Scenario:	BLS002F
Scenario Description:	3.0 mgd Peak I/I in Basin BLS002. Rehabilitation in BLS002 only that gives 1.81 mgd removal at 60% removal efficiency

Summary of I/I Removal - Cost Estimates

Description	Quantity	Unit	Unit Cost	Total Cost
Mains - Pipe Burst (easy)	0	LF	$ 134	$ -
Mains - Pipe Burst (difficult)	0	LF	$ 314	$ -
Mains - Pipe Lining (easy)	0	LF	$ -	$ -
Mains - Pipe Lining (difficult)	0	LF	$ -	$ -
Mains - Open Cut Replacement (easy)	0	LF	$ -	$ -
Mains - Open Cut Replacement (difficult)	0	LF	$ -	$ -
Manhole Replacement (easy)	0	EA	$ -	$ -
Manhole Replacement (difficult)	0	EA	$ -	$ -
Lateral Pipe Bursting (easy)	0	EA	$ -	$ -
Lateral Pipe Bursting (medium)	0	EA	$ -	$ -
Lateral Pipe Bursting (difficult)	0	EA	$ -	$ -
Lateral Lining (easy)	0	EA	$ -	$ -
Lateral Lining (medium)	0	EA	$ -	$ -
Lateral Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral Replacement (difficult)	0	EA	$ -	$ -
Side Sewer Pipe Bursting (easy)	0	EA	$ 3,310	$ -
Side Sewer Pipe Bursting (medium)	0	EA	$ 5,380	$ -
Side Sewer Pipe Bursting (difficult)	0	EA	$ 6,600	$ -
Side Sewer Lining (easy)	0	EA	$ -	$ -
Side Sewer Lining (medium)	0	EA	$ -	$ -
Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Lateral/Side Sewer Pipe Bursting (easy)	292	EA	$ 7,295	$ 2,130,140
Lateral/Side Sewer Pipe Bursting (medium)	51	EA	$ 8,515	$ 434,265
Lateral/Side Sewer Pipe Bursting (difficult)	0	EA	$ 11,220	$ -
Lateral/Side Sewer Lining (easy)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (medium)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Direct Disconnects	10	EA	$ 3,000	$ 30,000
			Subtotal	$ 2,594,405
			Sales Tax 9.0%	$ 233,496
			Construction Subtotal	$ 2,827,901
			Allied Cost 53.0%	$ 1,498,788
			Project Cost	$ 4,326,689
			Contingency 30.0%	$ 1,298,007
			Total Estimated Project Cost (2007 Dollars)	**$ 5,625,000**

Estimated Construction Cost Including Contingency

Construction Subtotal Incl. Sales Tax	$ 2,827,901
Contingency 30.0%	$ 848,370
Total Estimated Construction Cost (2007 Dollars)	**$ 3,676,300**

Summary of I/I Removal - I/I Reduction

Description	Source	Quantity	Units
General			
Projected 20-year I/I	King County	3	MGD
Assumed inflow estimate	Estimated	0.112	MGD
Remaining Basin I/I, (I/I minus inflow)		2.89	MGD
Acres	King County	109	ac
I/I per acre		26,494	gpad
Number of properties		386	
Total Quantities in Basin			
Total length of mainlines	CCTV Inspection	0	LF
Total number of laterals	Assume one lateral per property.	386	
Total number of side sewers	Assume one side sewer per lateral.	386	
Total number of lateral/side sewers	Assume one side sewer per lateral.	386	
Total number of manholes	GIS		
Total number of direct disconnects	Smoke test results	10	
Total Quantities in Basin - Rehabilitated			
Total length of mainlines - rehabilitated		0	LF
Total number of laterals - rehabilitated		0	
Total number of side sewers - rehabilitated		0	
Total number of lateral/side sewers - rehabilitated		343	
Total number of manholes - rehabilitated		0	
Total number of performed disconnections		10	
Percent Rehabilitated in Basin			
Mainlines rehabilitated		0%	
Laterals rehabilitated		0%	
Side sewers rehabilitated		0%	
Lateral/side sewers rehabilitated		89%	
Manholes rehabilitated		0%	
Performed disconnections		100%	
I/I Allocation in Basin (Private Properties)			
Percentage of private properties in basin over which I/I (I/I minus inflow) is to be apportioned	Assumed.	90%	
I/I allocation per property (no degradation)		5.8	gpm
Number of properties to be rehabilitated		343	
Private property estimated I/I reduction assuming 60% reduction (no degradation)		1.71	MGD
Private property estimated I/I reduction assuming 75% reduction (no degradation)		2.14	MGD
I/I Removal in Basin			
I/I removal due to performed disconnections (100% reduction assumed)		0.11	MGD
I/I removal due to private property rehabilitations (60% I/I reduction assumed per fixed property)		1.71	MGD
I/I removal due to private property rehabilitations (75% reduction assumed per fixed property)		2.14	MGD
Summary: I/I Removal (60% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	1.82	MGD
	Minimum Remaining I/I	1.2	MGD
	Minimum Remaining I/I	10,799	gpad
Summary: I/I Removal (75% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	2.25	MGD
	Minimum Remaining I/I	0.7	MGD
	Minimum Remaining I/I	6,875	gpad

Alternative BEL/ISS-B

Basin:	BEL 031
Date:	6/22/2008
Scenario:	BEL 031-E
Scenario Description:	95% of Easy & Medium Lateral & Side Sewer, excl PVC pipe

Summary of I/I Removal - Cost Estimates

Description	Quantity	Unit	Unit Cost	Total Cost
Mains - Pipe Burst (easy)	0	LF	$ -	$ -
Mains - Pipe Burst (difficult)	0	LF	$ -	$ -
Mains - Pipe Lining (easy)	0	LF	$ -	$ -
Mains - Pipe Lining (difficult)	0	LF	$ -	$ -
Mains - Open Cut Replacement (easy)	0	LF	$ -	$ -
Mains - Open Cut Replacement (difficult)	0	LF	$ -	$ -
Manhole Replacement (easy)	0	EA	$ -	$ -
Manhole Replacement (difficult)	0	EA	$ -	$ -
Lateral Pipe Bursting (easy)	0	EA	$ -	$ -
Lateral Pipe Bursting (medium)	0	EA	$ -	$ -
Lateral Pipe Bursting (difficult)	0	EA	$ -	$ -
Lateral Lining (easy)	0	EA	$ -	$ -
Lateral Lining (medium)	0	EA	$ -	$ -
Lateral Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral Replacement (difficult)	0	EA	$ -	$ -
Side Sewer Pipe Bursting (easy)	0	EA	$ 8,052	$ -
Side Sewer Pipe Bursting (medium)	0	EA	$ 9,047	$ -
Side Sewer Pipe Bursting (difficult)	0	EA	$ 16,445	$ -
Side Sewer Lining (easy)	0	EA	$ -	$ -
Side Sewer Lining (medium)	0	EA	$ -	$ -
Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Lateral/Side Sewer Pipe Bursting (easy)	82	EA	$ 9,995	$ 819,590
Lateral/Side Sewer Pipe Bursting (medium)	25	EA	$ 11,995	$ 299,875
Lateral/Side Sewer Pipe Bursting (difficult)	0	EA	$ 16,995	$ -
Lateral/Side Sewer Lining (easy)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (medium)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Direct Disconnects	2	EA	$ 3,000	$ 6,000
			Subtotal	$ 1,125,465
			Sales Tax 9.0%	$ 101,292
			Construction Subtotal	$ 1,226,757
			Allied Cost 53.0%	$ 650,181
			Project Cost	$ 1,876,938
			Contingency 30.0%	$ 563,081
			Total Estimated Project Cost (2007 Dollars)	**$ 2,440,000**

Estimated Construction Cost Including Contingency

Construction Subtotal Incl. Sales Tax		$ 1,226,757
Contingency	30.0%	$ 368,027
Total Estimated Construction Cost (2007 Dollars)		**$ 1,594,800**

Summary of I/I Removal - I/I Reduction

Description	Source	Quantity	Units
General			
Projected 20-year I/I	King County	1.31	MGD
Assumed inflow estimate	Estimated	0.063	MGD
Remaining Basin I/I, (I/I minus inflow)		1.25	MGD
Acres	King County	81.7	ac
I/I per acre		15,269	gpad
Number of properties		213	
Total Quantities in Basin			
Total length of mainlines	CCTV Inspection	14,475	LF
Total number of laterals	Assume one lateral per property.	213	
Total number of side sewers	Assume one side sewer per lateral.	213	
Total number of lateral/side sewers	Assume one side sewer per lateral.	213	
Total number of manholes	GIS	94	
Total number of direct disconnects	Smoke test results	2	
Total Quantities in Basin - Rehabilitated			
Total length of mainlines - rehabilitated		0	LF
Total number of laterals - rehabilitated		0	
Total number of side sewers - rehabilitated		0	
Total number of lateral/side sewers - rehabilitated		107	
Total number of manholes - rehabilitated		0	
Total number of performed disconnections		2	
Percent Rehabilitated in Basin			
Mainlines rehabilitated		0%	
Laterals rehabilitated		0%	
Side sewers rehabilitated		0%	
Lateral/side sewers rehabilitated		50%	
Manholes rehabilitated		0%	
Performed disconnections		100%	
I/I Allocation in Basin (Private Properties)			
Percentage of private properties in basin over which I/I (I/I minus inflow) is to be apportioned	Assumed.	90%	
I/I allocation per property (no degradation)		5	gpm
Number of properties to be rehabilitated		107	
Private property estimated I/I reduction assuming 60% reduction (no degradation)		0.42	MGD
Private property estimated I/I reduction assuming 75% reduction (no degradation)		0.52	MGD
I/I Removal in Basin			
I/I removal due to performed disconnections (100% reduction assumed)		0.06	MGD
I/I removal due to private property rehabilitations (60% I/I reduction assumed per fixed property)		0.42	MGD
I/I removal due to private property rehabilitations (75% reduction assumed per fixed property)		0.52	MGD
Summary: I/I Removal (60% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	0.48	MGD
	Minimum Remaining I/I	0.8	MGD
	Minimum Remaining I/I	10,155	gpad
Summary: I/I Removal (75% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	0.58	MGD
	Minimum Remaining I/I	0.7	MGD
	Minimum Remaining I/I	8,877	gpad

Alternative BEL/ISS-B

Basin:	ISS 003
Date:	6/20/2008
Scenario:	ISS 003D (2)
Scenario Description:	Rehabilitation of Easy and Medium properties

Summary of I/I Removal - Cost Estimates

Description	Quantity	Unit	Unit Cost	Total Cost
Mains - Pipe Burst (easy)	0	LF	$ -	$ -
Mains - Pipe Burst (difficult)	0	LF	$ -	$ -
Mains - Pipe Lining (easy)	0	LF	$ -	$ -
Mains - Pipe Lining (difficult)	0	LF	$ -	$ -
Mains - Open Cut Replacement (easy)	0	LF	$ -	$ -
Mains - Open Cut Replacement (difficult)	0	LF	$ -	$ -
Manhole Replacement (easy)	0	EA	$ -	$ -
Manhole Replacement (difficult)	0	EA	$ -	$ -
Lateral Pipe Bursting (easy)	0	EA	$ -	$ -
Lateral Pipe Bursting (medium)	0	EA	$ -	$ -
Lateral Pipe Bursting (difficult)	0	EA	$ -	$ -
Lateral Lining (easy)	0	EA	$ -	$ -
Lateral Lining (medium)	0	EA	$ -	$ -
Lateral Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral Replacement (difficult)	0	EA	$ -	$ -
Side Sewer Pipe Bursting (easy)	0	EA	$ 8,052	$ -
Side Sewer Pipe Bursting (medium)	0	EA	$ 9,047	$ -
Side Sewer Pipe Bursting (difficult)	0	EA	$ 16,445	$ -
Side Sewer Lining (easy)	0	EA	$ -	$ -
Side Sewer Lining (medium)	0	EA	$ -	$ -
Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Lateral/Side Sewer Pipe Bursting (easy)	37	EA	$ 9,995	$ 369,815
Lateral/Side Sewer Pipe Bursting (medium)	76	EA	$ 11,995	$ 911,620
Lateral/Side Sewer Pipe Bursting (difficult)	0	EA	$ 16,995	$ -
Lateral/Side Sewer Lining (easy)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (medium)	0	EA	$ -	$ -
Lateral/Side Sewer Lining (difficult)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (easy)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (medium)	0	EA	$ -	$ -
Open Cut Lateral/Side Sewer Replacement (difficult)	0	EA	$ -	$ -
Direct Disconnects	1	EA	$ 3,000	$ 3,000
			Subtotal	$ 1,284,435
			Sales Tax 9.0%	$ 115,599
			Construction Subtotal	$ 1,400,034
			Allied Cost 53.0%	$ 742,018
			Project Cost	$ 2,142,052
			Contingency 30.0%	$ 642,616
			Total Estimated Project Cost (2007 Dollars)	**$ 2,785,000**

Estimated Construction Cost Including Contingency

Construction Subtotal Incl. Sales Tax		$ 1,400,034
Contingency	30.0%	$ 420,010
Total Estimated Construction Cost (2007 Dollars)		**$ 1,820,000**

Summary of I/I Removal - I/I Reduction

Description	Source	Quantity	Units
General			
Projected 20-year I/I	King County	0.65	MGD
Assumed inflow estimate	Estimated	0.013	MGD
Remaining Basin I/I, (I/I minus inflow)		0.64	MGD
Acres	King County	81.4	ac
I/I per acre		7,826	gpad
Number of properties		133	
Total Quantities in Basin			
Total length of mainlines	CCTV Inspection	16,056	LF
Total number of laterals	Assume one lateral per property.	133	
Total number of side sewers	Assume one side sewer per lateral.	133	
Total number of lateral/side sewers	Assume one side sewer per lateral.	133	
Total number of manholes	GIS		
Total number of direct disconnects	Smoke test results	1	
Total Quantities in Basin - Rehabilitated			
Total length of mainlines - rehabilitated		0	LF
Total number of laterals - rehabilitated		0	
Total number of side sewers - rehabilitated		0	
Total number of lateral/side sewers - rehabilitated		113	
Total number of manholes - rehabilitated		0	
Total number of performed disconnections		1	
Percent Rehabilitated in Basin			
Mainlines rehabilitated		0%	
Laterals rehabilitated		0%	
Side sewers rehabilitated		0%	
Lateral/side sewers rehabilitated		85%	
Manholes rehabilitated		0%	
Performed disconnections		100%	
I/I Allocation in Basin (Private Properties)			
Percentage of private properties in basin over which I/I (I/I minus inflow) is to be apportioned	Assumed.	90%	
I/I allocation per property (no degradation)		3.7	gpm
Number of properties to be rehabilitated		113	
Private property estimated I/I reduction assuming 60% reduction (no degradation)		0.36	MGD
Private property estimated I/I reduction assuming 75% reduction (no degradation)		0.45	MGD
I/I Removal in Basin			
I/I removal due to performed disconnections (100% reduction assumed)		0.01	MGD
I/I removal due to private property rehabilitations (60% I/I reduction assumed per fixed property)		0.36	MGD
I/I removal due to private property rehabilitations (75% reduction assumed per fixed property)		0.45	MGD
Summary: I/I Removal (60% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	0.37	MGD
	Minimum Remaining I/I	0.3	MGD
	Minimum Remaining I/I	3,393	gpad
Summary: I/I Removal (75% I/I Reduction Assumed for Private Properties; No Degradation)			
	Total I/I Removal	0.46	MGD
	Minimum Remaining I/I	0.2	MGD
	Minimum Remaining I/I	2,285	gpad

King County

Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report

APPENDIX D.
PERMITTING REQUIREMENTS

April 2009

Permitting Technical Memorandum
King County Inflow and Infiltration Project
King County, Washington

March 6, 2009

Submitted To:
Mr. Jeffrey Lykken
Tetra Tech
1420 Fifth Avenue, Suite 600
Seattle, Washington 98101

By:
Shannon & Wilson, Inc.
400 N 34th Street, Suite 100
Seattle, Washington 98103

21-1-20792-008

TABLE OF CONTENTS

LIST OF TABLES

Table No.

LIST OF FIGURES

Figure No.

PERMITTING TECHNICAL MEMORANDUM
KING COUNTY INFLOW/INFILTRATION PROJECT
KING COUNTY, WASHINGTON

This technical memorandum summarizes the local, state, and federal permits that may be needed for the proposed sewer rehabilitation work in targeted properties in mini-basins ISS003, BLS002, and BEL031. It is our understanding that the proposed rehabilitation work will be limited to pipe bursting, with the potential for small amounts of cure-in-place lining and open cut construction.

1.0 MINI-BASIN ISS003

We understand that within mini-basin ISS003, King County (the County) plans to conduct sewer rehabilitation work on 37 properties identified as easy and 76 properties identified as medium on the ISS003 Parcel Difficulty Ratings map (Figure 1). This project will require permits from the City of Issaquah (Issaquah) and the County. If the project team cannot avoid work within wetlands or streams, state and federal permits will also be required.

1.1 Required Permits

1.1.1 Street Use Permit – City of Issaquah (Issaquah)

A street use permit will be required by Issaquah for work conducted within an existing street right-of-way (ROW). The street use permit application should include a traffic control plan and drawings showing where work will occur.

1.1.2 Side Sewer Permit – Issaquah

A side sewer permit may be required for work on existing side sewers located on private property or in the public ROW. The project approach will be to conduct work under a blanket side sewer permit. Bonita McPherren of Issaquah's Public Works Department manages side sewer permits for the City. She is out of the office until December 9, 2008. Based on our discussion with an Issaquah permit technician, Issaquah generally issues separate side sewer permits for each individual property. Further investigation and communication with Ms. McPherren is needed to determine whether the City will issue a blanket side sewer permit.

The side sewer permit application should include drawings showing the size and location of the existing structures on the property and the full course of the proposed side sewer from the public sewer to the structure. The permit application must indicate whether any easements would be required and whether they have been obtained and recorded with the County.

1.1.3 Clearing and Grading Permit – Issaquah

Issaquah does not require a clearing and grading permit for earthwork conducted by utilities in an existing street ROW. If earthwork is not in an existing street ROW, Issaquah will require a clearing and grading permit for disturbance of 1,000 square feet (sf) or more of vegetation and/or movement of 30 cubic yards (cy) or more of earth. A clearing and grading permit is also required for any earthwork or clearing in a critical area.

1.1.4 Shoreline Management Act (SMA) Review – Issaquah

Six easy parcels and 12 medium parcels identified within mini-basin ISS003 are located within Issaquah's preliminary shoreline jurisdiction (Figure 1, Sheet 1) and would require SMA review. A shoreline exemption or a Shoreline Substantial Development Permit (SSDP) is required, under SMA, for work conducted within shoreline jurisdiction.

Additional investigation and coordination with the design team is required to determine whether work within the shoreline jurisdiction is needed and whether the proposed work will qualify for an exemption to the SMA under Washington Administrative Code 173-27-040(2)(b) for normal maintenance or repair of existing structures or developments. If proposed work cannot be modified to fit into an exempted activity, an SSDP may be required.

1.1.5 Critical Areas Review – Issaquah

It is our understanding that the project will avoid impacts to wetlands and streams. However, 16 easy parcels and 38 medium parcels identified within mini-basin ISS003 may extend into wetland or stream buffers (see Figure 1, Sheet 2). Work within wetland or stream buffers will require a critical areas review by the Issaquah. If work is conducted within undisturbed wetland or stream buffers, mitigation may be required.

Based on the targeted properties in mini-basin ISS003, proposed work will likely require a critical areas review. Critical areas review and any mitigation plans for impacts to critical areas must be submitted with the State Environmental Policy Act (SEPA) review application.

For the purposes of this assessment, buffer widths are based on our field reconnaissance and background review of approximate wetland and stream boundaries and stream classes. This assessment assumes the highest standard wetland buffer width required under Issaquah Municipal Code. Wetland delineation and rating assessments, to determine wetland categories, would be required to provide a more precise determination of wetland buffer extents.

1.1.6 SEPA – King County (the County)

The proposed work is likely not SEPA exempt because there may be changes and/or expansions in the sewer system. SEPA review will be required for work in all the project areas by the lead local agency, the County, and will be limited to completing an environmental checklist. Critical area evaluations and proposed mitigation will be addressed in the SEPA environmental checklist. Based on the King County Infiltration/Inflow Pilot Study and the nature and location of the proposed work, we anticipate that SEPA review of the project will result in a Mitigated Determination of Non-Significance.

1.2 Other Potential Permits

It is our understanding that no work in-water (including wetlands and streams) will occur, that ground disturbance will be less than 1 acre, and the project does not have a federal nexus (e.g. federal funding, work on federal land, or federal permitting.) Therefore, no state or federal permits will be required. However, if work in-water (including wetlands and streams) is proposed then the following permits may be required:

- Hydraulic Project Approval (HPA) from the Washington State Department of Fish and Wildlife (WDFW).
- Clean Water Act (CWA) Section 404 Permit from the Army Corps of Engineers.
- CWA Section 401 Water Quality Certification from the Washington State Department of Ecology (Ecology).

If ground disturbance greater than 1 acre will occur then a National Pollutant Discharge Elimination System (NPDES) Permit will be required by Ecology.

If the project has a federal nexus, compliance with National Environmental Policy Act (NEPA) and Section 7 of the Endangered Species Act (ESA) will be required.

2.0 MINI-BASIN BEL031

We understand that within mini-basin BEL031, the County plans to conduct sewer rehabilitation work on 82 properties identified as easy and 25 properties identified as medium on the BEL031 Parcel Difficulty Ratings map (Figure 2). This project will require permits from the City of Bellevue and King County. If the project team cannot avoid work within wetlands or streams, state and federal permits will also be required.

2.1 Required Permits

2.1.1 Right-of-Way (ROW) Use Permit – City of Bellevue (Bellevue)

Bellevue will require a ROW use permit for work conducted within an existing ROW. The right of way use permit application should include a traffic control plan and drawings showing where work will occur.

2.1.2 Side Sewer Permit –Bellevue

Bellevue may require a side sewer permit for work on existing side sewers. The project approach will be to conduct work under a blanket side sewer permit. Further investigation is required to determine how the Bellevue will issue side sewer permits.

The side sewer permit application should include drawings showing the size and location of the existing structures on the property and the full course of the proposed side sewer from the public sewer to the structure. The permit application must indicate whether any easements would be required and whether they have been obtained and recorded with the County.

2.1.3 Clearing and Grading Permit – Bellevue

Bellevue will require a grading permit for the removal or destruction of 1,000 sf or more of vegetation and/or movement of 50 cy or more of earth.

2.1.4 Critical Areas Review – Bellevue

It is our understanding that the project will avoid impacts to wetlands and streams. However, three easy parcels and three medium parcels identified within mini-basin BEL031 may extend into wetland buffer (see Figure 2). If work cannot be avoided within wetland buffers, a critical areas review will be required. If work is conducted within undisturbed wetland buffer, mitigation may be required. Critical areas review and any mitigation plans for impacts to critical areas must be submitted with the SEPA review application.

For the purposes of this assessment buffer widths are based on our field reconnaissance and background review of approximate wetland boundaries. This assessment assumes the highest standard buffer width required under Bellevue Municipal Code. A wetland delineation and rating assessment, to determine wetland category, would be required to provide a more precise determination of wetland buffer extent.

2.1.5 SEPA – County

The proposed work is likely not SEPA exempt because there may be changes and/or expansions in the sewer system. SEPA review will be required for work in all the project areas by the lead local agency, the County, and will be limited to completing an environmental checklist. Critical area evaluations and proposed mitigation will be addressed in the SEPA environmental checklist. Based on the King County Infiltration/Inflow Pilot Study and the nature and location of the proposed work, we anticipate that SEPA review of the project will result in a Mitigated Determination of Non-Significance.

2.2 Other Potential Permits

It is our understanding that no work in-water (including wetlands) will occur, that ground disturbance will be less than 1 acre, and the project does not have a federal nexus (e.g., federal funding, work on federal land, or federal permitting.) Therefore, no state or federal permits will be required. However, if work in-water (including wetlands) is proposed then the following permits may be required:

- CWA Section 404 Permit from the U.S. Army Corps of Engineers.
- CWA Section 401 Water Quality Certification from Ecology.

If ground disturbance greater than 1 acre will occur, then a NPDES Permit will be required by Ecology. If the project has a federal nexus, compliance with NEPA Section 7 of the ESA will be required.

3.0 MINI-BASIN BLS002

We understand that within mini-basin BLS002, the County plans to conduct sewer rehabilitation work on 292 properties identified as easy and 51 properties identified as medium on the BLS002 Parcel Difficulty Ratings map (Figure 3). This project will require permits from the County, WDFW, and the U.S. Fish and Wildlife Service (USFWS). If the project team cannot avoid work within wetlands, streams, or 200 feet from Lake Washington, additional local, state, and federal permits will also be required.

3.1 Required Permits

3.1.1 Street Use Permit – County

A street use permit will be required by the County for work conducted within an existing street ROW. The street use permit application should include a traffic control plan and drawings showing where work will occur.

3.1.2 Clearing and Grading Permit – County

The County will require a clearing and grading permit for any earthwork in critical areas and/or earthwork of 100 cy or more in non-critical areas.

3.1.3 Critical Areas Review – County

It is our understanding that the project will avoid any impacts to wetlands and streams. However, 18 easy parcels and one medium parcel identified within mini-basin BLS002 may extend into stream buffer (see Figure 3). If work cannot be avoided within the steam buffer, a critical areas review will be required. If work is conducted in undisturbed stream buffer, mitigation may be required.

In addition, a bald eagle nest was observed in the southeast portion of the project area. If work is conducted within 400 feet of an active bald eagle nest, then a critical areas review will be required. Any work within 800 feet of a nest may also be subject to seasonal restrictions under the County's Critical Areas Ordinance. Mitigation for work conducted in the vicinity of the bald eagle nest, may include work windows or other restrictions.

Critical areas review and any mitigation plans for impacts to stream buffers or wildlife habitat conservation areas must be submitted with the SEPA review application.

3.1.4 SEPA – County

The proposed work is likely not SEPA exempt because there may be changes and/or expansions in the sewer system. SEPA review will be required for work in all the project areas by the lead local agency, the County, and will be limited to completing an environmental checklist. Critical area evaluations and proposed mitigation will be addressed in the SEPA environmental checklist. Based on the King County Infiltration/Inflow Pilot Study and the nature and location of the proposed work, we anticipate that SEPA review of the project will result in a Mitigated Determination of Non-Significance.

3.1.5 Bald Eagle Management Plan - WDFW

Bald eagle habitat is protected in Washington State under the Bald Eagle Protection Law of 1984. If work will occur between 400 feet and 800 feet from the project area nest, a Standard Management Plan will be required by WDFW. Standard management plans are pre-approved by WDFW and restrict removal of trees. If work will occur within 400 feet of the nest, a Site-Specific Management Plan will be required. The Site-Specific Management Plan will establish conditions to ensure activities will have minimal impact on bald eagles.

3.1.6 National Bald Eagle Management Guidelines – U.S. Fish and Wildlife Service (USFWS)

Bald eagles are protected under federal law by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The USFWS is currently developing a permitting process for activities that are likely to impact bald eagles. Activities that comply with the National Bald Eagle Management Guidelines (May 2007) will not require review by USFWS.

Proposed work that will occur within 660 feet of an active or alternate bald eagle nest, will not comply with National Bald Eagle Management Guidelines and will require coordination with the USFWS. The proposed work may be subject to seasonal restrictions, clearing restrictions, and other requirements.

3.2 Other Potential Permits

It is our understanding that no work will occur within 200 feet of Lake Washington. However, if work is proposed within 200 feet of Lake Washington, a SMA review will be required by the County.

Additionally, we understanding that no work in-water (including streams) will occur, that ground disturbance will be less than 1 acre, and the project does not have a federal nexus (e.g., federal funding, work on federal land, or federal permitting). Therefore, state or federal permits requirements will be limited to bald eagle protection. However, if in-stream work is proposed then the project will require a HPA from WDFW. If ground disturbance greater than 1 acre will occur then a NPDES Permit will be required by Ecology. If the project has a federal nexus, compliance with NEPA and Section 7 of the ESA will be required.

4.0 CLOSURE

Several local permits will be required for the proposed project. If work will occur directly in wetlands or streams, several state and/or federal permits may also be required. Tables 1 – 3 summarize the permits likely required for this project, supporting documents, and estimated time of permit issuance.

SHANNON & WILSON, INC.

Becki Kniveton, PWS
Senior Wetland Biologist

BXE:BSK:KLW/bxe

TABLE 1. ESTIMATED PERMIT TIMELINE
KING COUNTY INFILTRATION/INFLOW PROJECT
MINI-BASIN ISS003

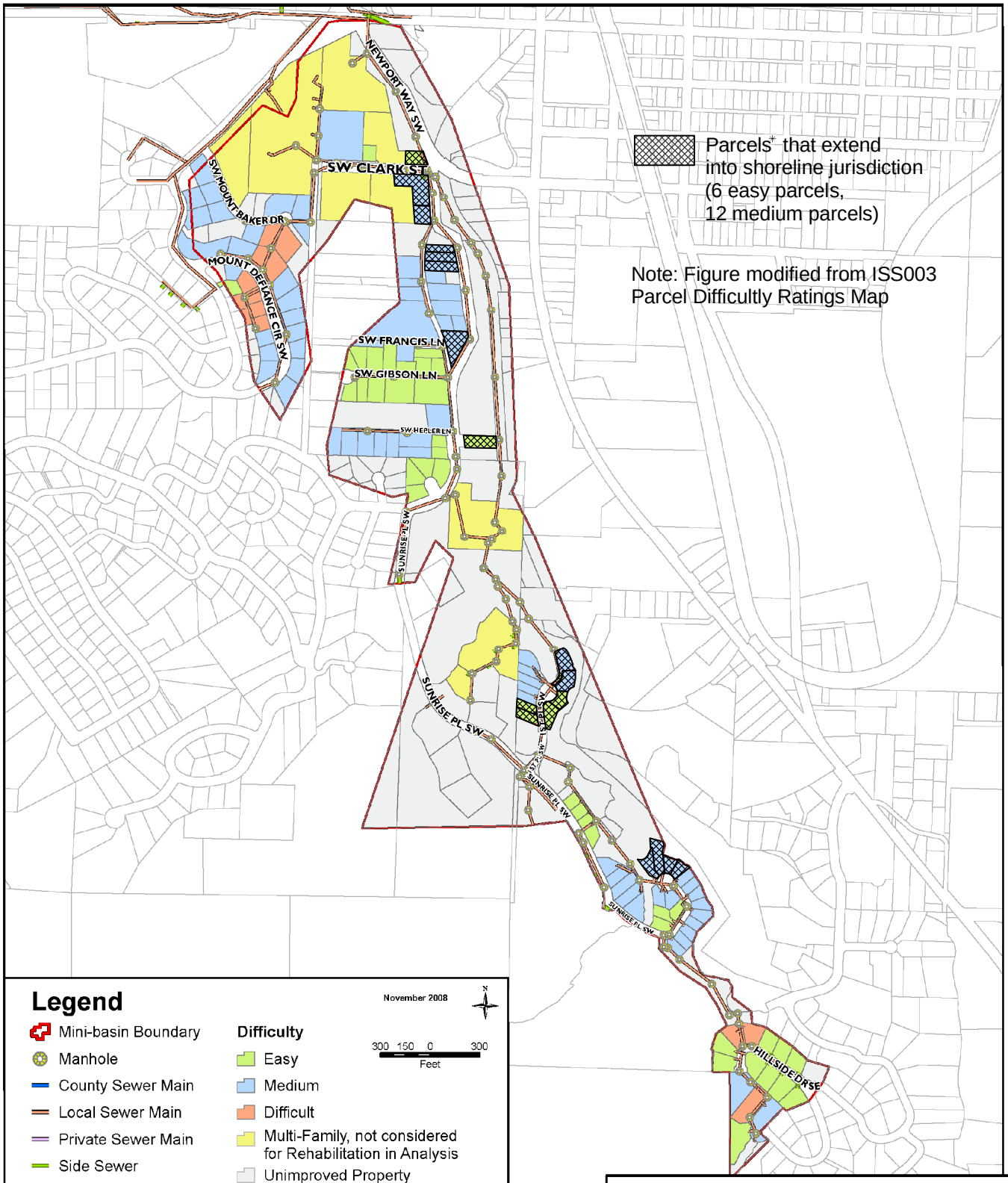
Permit	Trigger	Issuing Agency	Permit Application Materials	Comments	Time to Prepare and Submit Application	Estimated Time of Permit Issuance
Required Permits						
Street Use Permit	Work within an existing street right-of-way	City of Issaquah	1) Street Use Permit Application: 2) Traffic Control Plan; 3) Design drawings showing intended use of right-of-way; 4) Paving restoration or schematic		2 weeks	2 to 3 weeks
Side Sewer Permit/Utility	Any modification of an existing side sewer		1) Side Sewer Permit Application 2) Drawings showing the size and location of the existing structures the proposed side sewer. 3) Proof of any required easements that have been recorded with King County		2 weeks after easements are obtained	2 to 3 weeks
Clearing and Grading Permit	Disturbance of 1,000 sf or more of vegetation and/or movement of 30 cy or more of earth outside of an existing right-of-way. Any clearing or grading within a critical area		1) Design drawings showing clearing and grading limits; 2) Pre-application site visit to verify the presence or absence of environmentally critical areas	Permit would not be required if less than 1,000 sq of clearing or less than 30 cubic yards of grading will occur outside of existing street right-of-way or any clearing	2 weeks	reviewed concurrently with SEPA
Shoreline Management Act Review	Construction within the shoreline jurisdiction including 200 ft from Issaquah Creek and associated wetlands		1) Shoreline Exemption Request letter, or 2) Shoreline Substantial Development Permit application with design drawings (30-60% design) and a completed SEPA Checklist and determination will be required for a SSDP	A shoreline exemption permit may be issued if work in shoreline jurisdiction qualifies under WAC 173-27-040(2)(b) as normal maintenance or repair of existing structures or developments	2 weeks for a Shoreline Exemption Permit.; 5 to 6 weeks for a Shoreline Substantial Development Permit (SSDP)	8 weeks for a Shoreline Exemption Permit; 5 months for an SSDP
Critical Areas Review	Work conducted within a critical area, including wetland and stream buffers		1) Wetland and/or stream delineation and assessment; 2) Wetland and/or stream mitigation plan		5 to 6 weeks after 70 percent design is complete	1 to 3 months
SEPA	Any proposed government action defined in the SEPA Rules (WAC 197-11-704), that is not categorically exempt (WAC 197-11-800 through 890)	King County	State Environmental Policy Act (SEPA) Checklist and wetland and/or stream mitigation plan		5 to 6 weeks after 70 percent design is complete	45 days after application is deemed complete
Potentially Required Permits						
Hydraulic Project Approval (HPA)	Construction activities that will occur over or in streams	Washington Department of Fish & Wildlife	1) JARPA form; 2) Stream mitigation plan; 3) Design drawings and specifications with maps; 4) SEPA decision letter	Permit will not be required unless work occurs over or in streams	3 to 6 weeks after 70 percent design is complete	45 calendar days after the application is deemed complete and SEPA compliance is complete
Section 404 Permit	Construction activities that will occur within waters of the United States, including streams and non-isolated wetlands	U.S. Army Corps of Engineers	1) Joint Aquatic Resource Permits Application (JARPA); 2) Biological Assessment/Essential Fish Habitat Assessment; 3) Wetland and/or stream delineation report; 4) Wetland and/or stream mitigation plan; 5) Design drawings and specifications with maps	Permit will not be required unless work occurs in streams or wetlands	4 to 6 weeks after 70 percent design is complete	4 to 12 months, depending on project complexity
Section 401 Permit and Coastal Zone Management Act approval	Construction activities that will occur within waters of the State, including streams and wetlands	Washington Department of Ecology	1) JARPA form; 2) Wetland and/or stream delineation report; 3) Wetland and/or stream mitigation plan	Permit will not be required unless work occurs in streams or wetlands	5 to 6 weeks after 70 percent design is complete	3 months
National Pollution Discharge Elimination System (NPDES) (for construction)	Disturbance of >1 acre		Storm Water Pollution Prevention Plan (SWPPP)	Permit will not be required for less than 1 acre of earthwork	typically prepared and submitted by contractor	30 days

TABLE 2. ESTIMATED PERMIT TIMELINE
KING COUNTY INFILTRATION/INFLOW PROJECT
MINI-BASIN BEL031

Permit	Trigger	Issuing Agency	Permit Application Materials	Comments	Time to Prepare and Submit Application	Estimated Time of Permit Issuance
Required Permits						
Right of Way Use Permit	Any activity the disrupts traffic, restricts access or modifies any infrastructure within the right of way	City of Bellevue	1) Right of Way Use Permit Application: 2) Traffic Control Plan; 3) Design drawings showing intended use of right-of-way; 4) Paving restoration or schematic		2 weeks	2 to 3 weeks
Side Sewer Permit/Utility	Work conducted on side sewers		1) Side Sewer Permit Application 2) Drawings showing the size and location of the existing structures the proposed side sewer. 3) Proof of any required easements that have been recorded with King County		2 weeks after easements are obtained	2 to 3 weeks
Clearing and Grading Permit	Removal or destruction of 1,000 square feet or more of vegetation and/or movement of 50 cubic yards or more of earth.		1) Design drawings showing clearing and grading limits; 2) Pre-application site visit to verify the presence or absence of environmentally critical areas	Clearing and grading in critical areas is generally not allowed without mitigation	2 weeks	reviewed concurrently with SEPA
Critical Areas Review	Work conducted within a critical area, including wetland buffers		1) Wetland delineation and assessment; 2) Wetland mitigation plan		5 to 6 weeks after 70 percent design is complete	1 to 3 months
SEPA	Any proposed government action defined in the SEPA Rules (WAC 197-11-704), that is not categorically exempt (WAC 197-11-800 through 890)	King County	State Environmental Policy Act (SEPA) Checklist and wetland mitigation plan		5 to 6 weeks after 70 percent design is complete	45 days after application is deemed complete
Potentially Required Permits						
Section 404 Permit	Construction activities that will occur withinwaters of the United States, including streams and non-isolated wetlands	U.S. Army Corps of Engineers	1) Joint Aquatic Resource Permits Application (JARPA); 2) Biological Assessment/Essential Fish Habitat Assessment; 3) Wetland and/or stream delineation report; 4) Wetland and/or stream mitigation plan; 5) Design drawings and specifications with maps	Permit will not be required unless work occurs in streams or wetlands	4 to 6 weeks after 70 percent design is complete	4 to 12 months, depending on project complexity
Section 401 Permit and Coastal Zone Management Act approval	Construction activities that will occur within waters of the State, including streams and wetlands	Washington Department of Ecology	1) JARPA form; 2) Wetland and/or stream delineation report; 3) Wetland and/or stream mitigation plan	Permit will not be required unless work occurs in streams or wetlands	5 to 6 weeks after 70 percent design is complete	3 months
National Pollution Discharge Elimination System (NPDES) (for construction)	Disturbance of >1 acre		Storm Water Pollution Prevention Plan (SWPPP)	Permit will not be required for less than 1 acre of earthwork	typically prepared and submitted by contractor	30 days

TABLE 3. ESTIMATED PERMIT TIMELINE
KING COUNTY INFILTRATION/INFLOW PROJECT
MINI-BASIN BLS002

Permit	Trigger	Issuing Agency	Permit Application Materials	Comments	Time to Prepare and Submit Application	Estimated Time of Permit Issuance
Required Permits						
Street Use Permit	Work within an existing street right-of-way	King County	1) Street Use Permit Application: 2) Traffic Control Plan; 3) Design drawings showing intended use of right-of-way; 4) Paving restoration or schematic		2 weeks	2 to 3 weeks
Clearing and Grading Permit	Any earthwork in critical areas and/or earthwork of 100 cubic yards or more in non-critical areas.		1) Design drawings showing clearing and grading limits; 2) Pre-application site visit to verify the presence or absence of environmentally critical areas	Work within 800 ft of a bald eagle nest may be subject to seasonal restrictions under the County's Critical Area Ordinance	2 weeks	reviewed concurrently with SEPA
Critical Areas Review	Work conducted within a critical area, including stream buffers and within 400 ft of a bald eagle nest		1) Stream and/or wildlife habitat assessment; 2) Stream and/or wildlife habitat avoidance and mitigation plan		5 to 6 weeks after 70 percent design is complete	1 to 3 months
SEPA	Any proposed government action defined in the SEPA Rules (WAC 197-11-704), that is not categorically exempt (WAC 197-11-800 through 890)		State Environmental Policy Act (SEPA) Checklist and wetland and/or wildlife habitat avoidance and mitigation plan		5 to 6 weeks after 70 percent design is complete	45 days after application is deemed complete
Bald Eagle Management Plan	Work within 800 feet of a bald eagle nest	WDFW	For a Site-Specific Management Plan: 1) Parcel/vicinity map; 2) Site map showing location of nest, structures, conifers over 24 dbh and location of activities		A site visit by WDFW may be required for a Site-Specific Management Plan	<1 week for a Standard Management Plan; 2-6 weeks for a Site-Specific Management Plan
National Bald Eagle Management Guidelines	Work within 660 ft of an active or alternate nest	USFWS	No permitting process is currently established. Coordination with USFWS will be required			
Potentially Required Permits						
Hydraulic Project Approval (HPA)	Construction activities that will occur over or in streams	Washington Department of Fish & Wildlife	1) JARPA form; 2) Stream mitigation plan; 3) Design drawings and specifications with maps; 4) SEPA decision letter	Permit will not be required unless work occurs over or in stream	3 to 6 weeks after 70 percent design is complete	45 calendar days after the application is deemed complete and SEPA compliance is complete
Section 404 Permit	Construction activities that will occur withinwaters of the United States, including streams and non-isolated wetlands	U.S. Army Corps of Engineers	1) Joint Aquatic Resource Permits Application (JARPA); 2) Biological Assessment/Essential Fish Habitat Assessment; 3) Wetland and/or stream delineation report; 4) Wetland and/or stream mitigation plan; 5) Design drawings and specifications with maps	Permit will not be required unless work occurs in streams or wetlands	4 to 6 weeks after 70 percent design is complete	4 to 12 months, depending on project complexity
Section 401 Permit and Coastal Zone Management Act approval	Construction activities that will occur within waters of the State, including streams and wetlands	Washington Department of Ecology	1) JARPA form; 2) Wetland and/or stream delineation report; 3) Wetland and/or stream mitigation plan	Permit will not be required unless work occurs in streams or wetlands	5 to 6 weeks after 70 percent design is complete	3 months
National Pollution Discharge Elimination System (NPDES) (for construction)	Disturbance of >1 acre.		Storm Water Pollution Prevention Plan (SWPPP)	Permit will not be required for less than 1 acre of earthwork	typically prepared and submitted by contractor	30 days



*Based on guidance from Tetra Tech, only easy and medium parcels were assessed.

King County I/I
King County, Washington

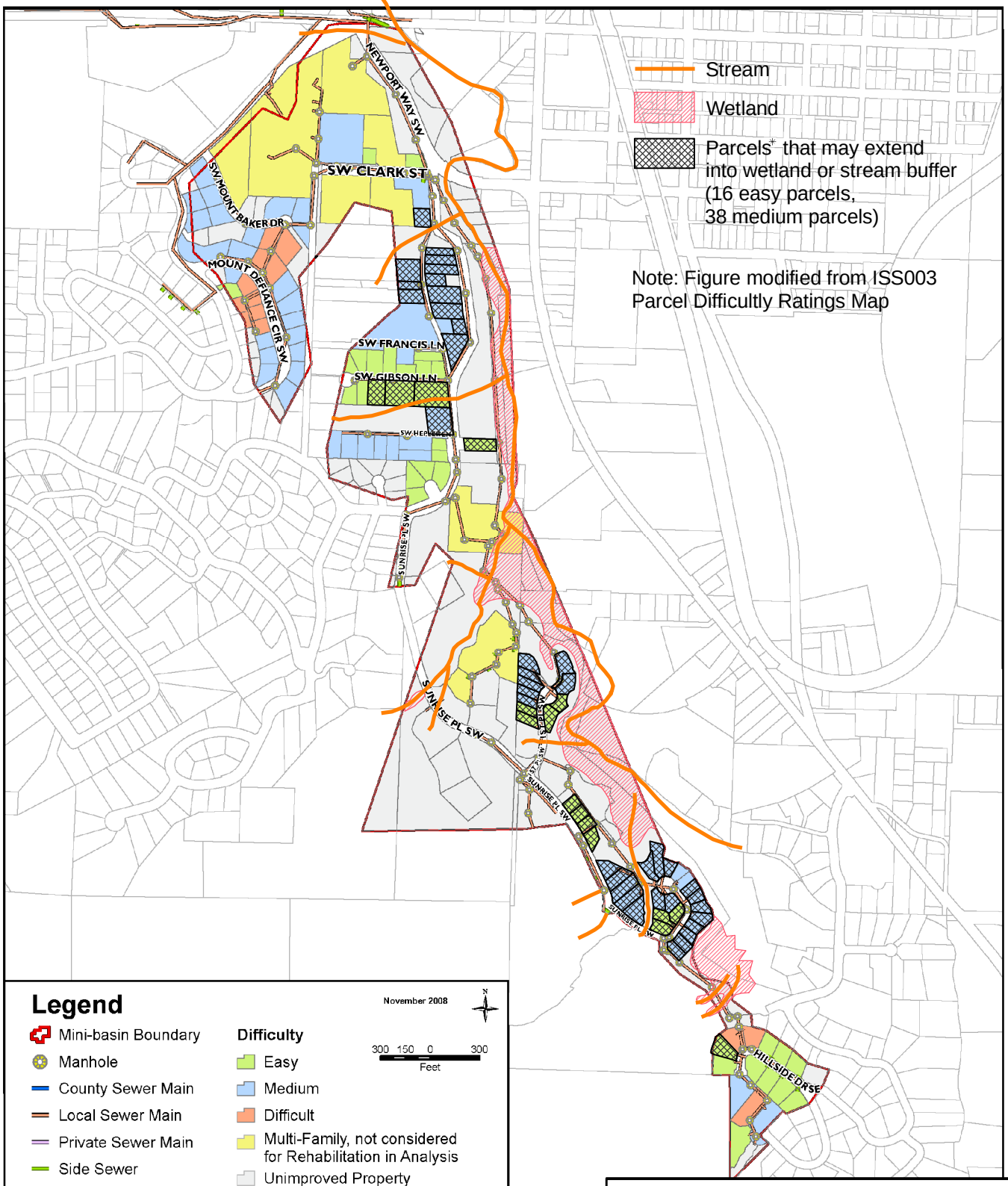
MINI-BASIN ISS003

December 2008 21-1-20792-008

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1
Sheet 1 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\PermittingAssess\ISS003.mxd BXE 12/02/2008



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

The information included on this map has been compil
subject to change without notice. King County makes
express or implied, as to accuracy, completeness, tim
information. This document is not intended for use as
shall not be liable for any general, special, indirect, inc
including, but not limited to, lost revenues or lost prof
of the information contained on this map. Any sale of
is prohibited except by written permission of King Cou

File Name: K:\kingco_i\Issaquah\ISS003_difficulty_rep

Data Source: King County

*Based on guidance from Tetra Tech, only easy and medium parcels were assessed.

King County I/I
King County, Washington

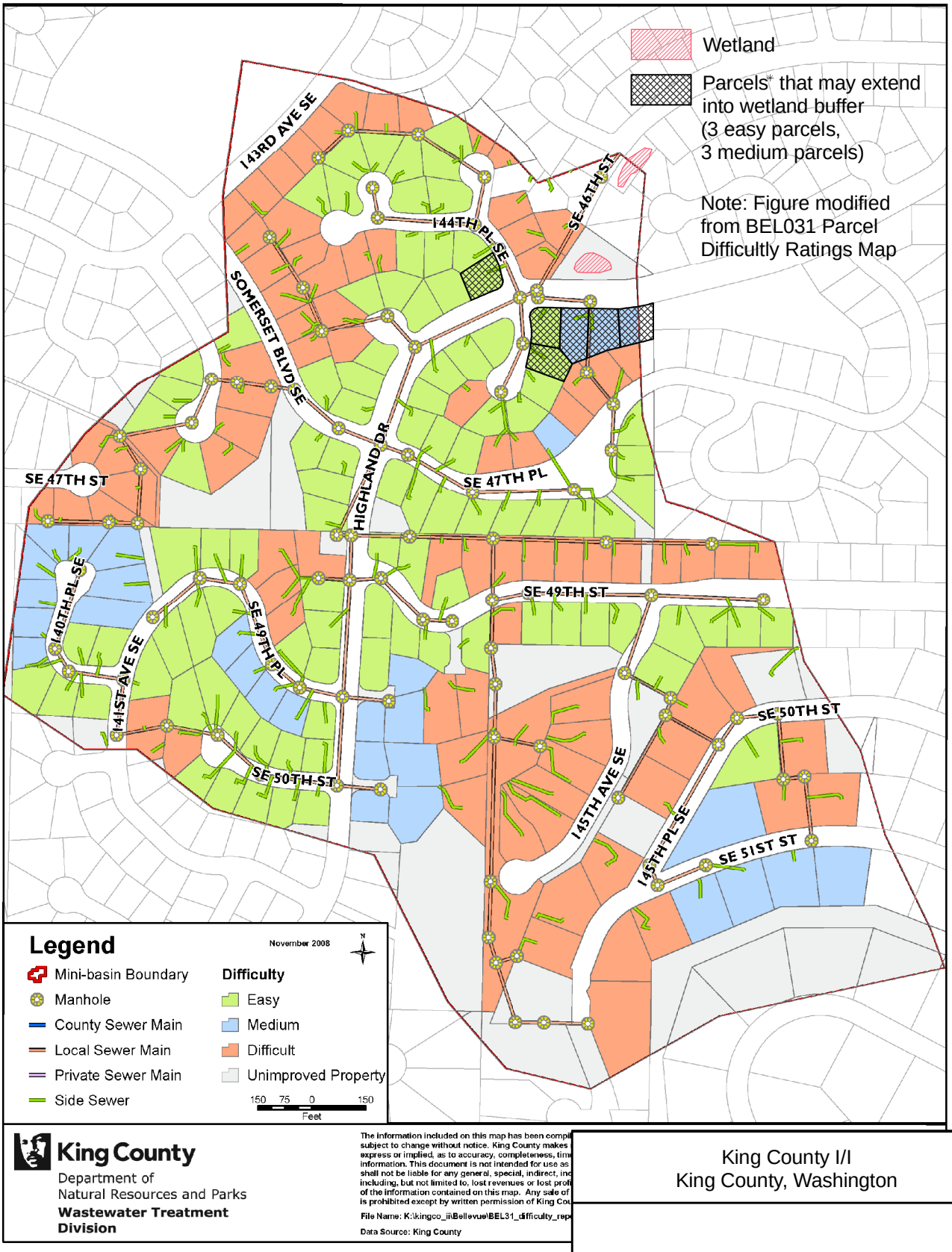
MINI-BASIN ISS003

December 2008 21-1-20792-008

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1
Sheet 2 of 2

Filename: T:\Project\21-1\20792_I&I\AV_mxd\PermittingAssess\ISS003.mxd BXE 12/02/2008



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: K:\kingco_ii\Bellevue\BEL31_difficulty_rep

Data Source: King County

King County I/I
King County, Washington

MINI-BASIN BEL031

December 2008 21-1-20792-008

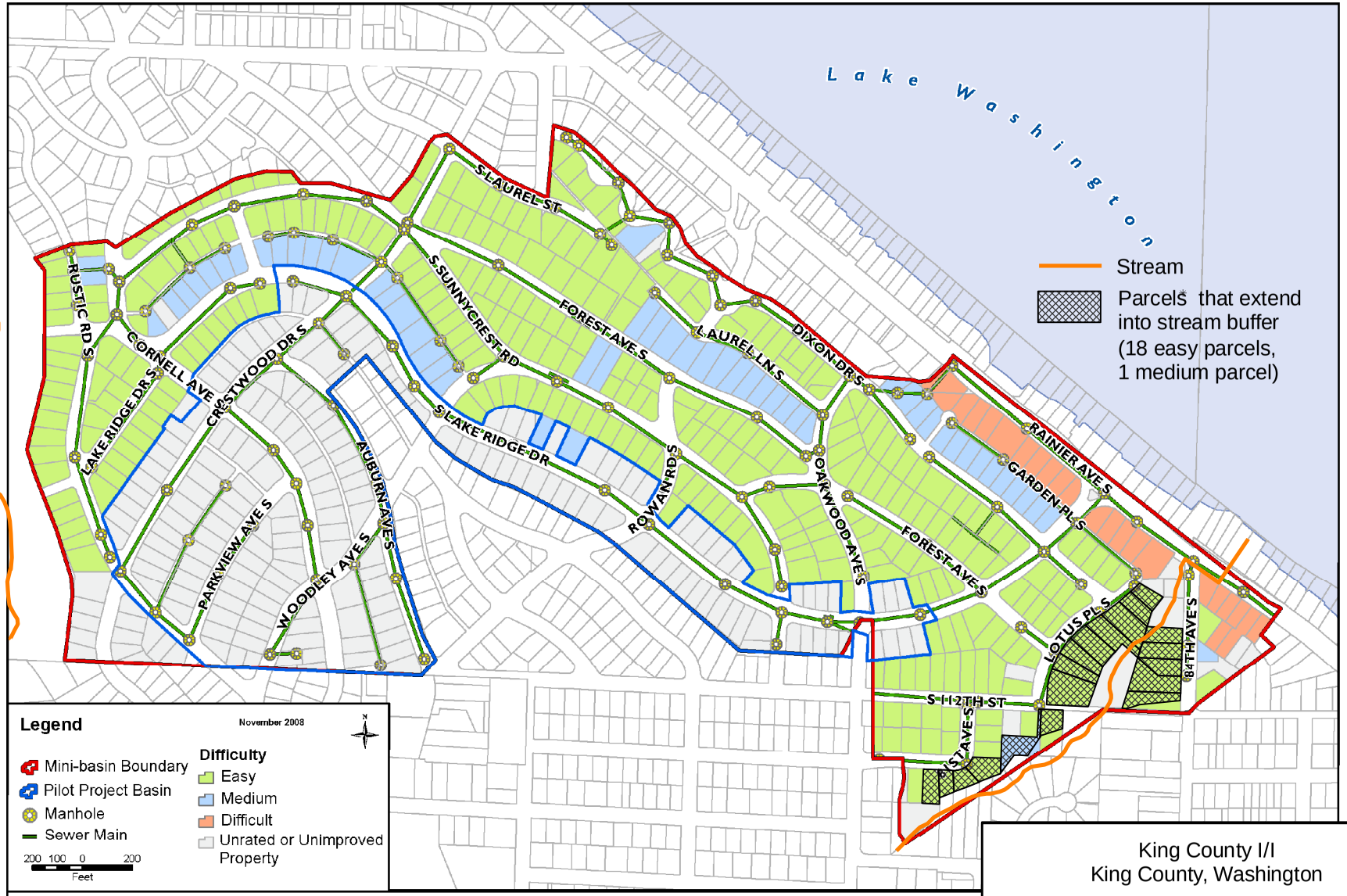
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 2

*Based on guidance from Tetra Tech, only easy and medium parcels were assessed.

Filename: T:\Project\21-1\20792_I&I\AV_mxd\PermittingAssess\BEL031.mxd BXE 12/02/2008

Filename: T:\Project\21-1\20792_I&I\AV_mxd\PermittingAssess\BLS002.mxd BXE 12/02/2008



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

File Name: K:\kingco_i\Skyway\BLS002_difficulty_reportfig

Data Source: King County

King County I/I
King County, Washington

MINI-BASIN BLS002

December 2008 21-1-20792-007

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 3

Note: Figure modified from BLS002 Parcel Difficultly Ratings Map

+ Based on guidance from Tetra Tech, only easy and medium parcels were assessed.

King County

Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report

APPENDIX E.
RISK ASSESSMENT RESULTS

April 2009

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
1.0	**Right of Way, Easement and Property Acquisition**							
1.1	Sufficient right-of-entries for low and medium properties are not attained requiring higher difficulty properties to be rehabbed at a higher cost.	M	H	MH	40%	$ 457,600	$ 183,040	Key to addressing this risk is to strive to attain more ROE's than needed to reach I/I removal targets.
1.2	Sufficient right-of-entries are not attained for the planned amount of private property rehabilitation. Project cannot proceed to implementation (Skyway)	H	H	HH	50%	$ 500,000	$ 250,000	* Explain the financial benefits of participation through communications materials. Key to addressing this risk is to strive to attain more ROE's than needed to reach I/I removal targets.
1.3	King County is understaffed to collect and/or record right-of-entries in a timely fashion	L	H	LH			$ -	Find right person/ consultant to do the collection work and a good collection system is set up Accurately identify number of ROE's required to ensure proper staffing is available to secure.
1.4	There are errors in right-of-entry records	L	M	LM			$ -	Find right person/ consultant to do the collection work and a good collection system is set up Establish accurate database for tracking of ROE's.
1.5	Work is done on wrong property, special conditions are not met during field work	L	M	LM			$ -	Field staff confirm work locations visually on map as well as by address. * See mitigation steps in 8.3 and 8.6 about project team and contractor briefings.
1.6	High property acquisition cost leading to increase in project cost higher than expected.	L	L	LL			$ -	ID all properties in question before doing work; do not work on properties that require acquisitions
2.0	**Permit Acquisition (List all Permits)**							
2.1	Permit mitigation requirements (for items such as pavement overlays; drainage improvements; etc.) increase project costs higher than expected.	L	L	LL			$ -	Negotiate on mitigation costs before proceeding with design Establish mitigation requirements for all required permits and reflect in contract bid documents.
2.2	Discharge permits needed for construction dewatering may delay construction, limit amount of allowable discharge, and may require water treatment prior to disposal	L	L	LL			$ -	Investigate discharge permits needed Acquire Dewatering permits prior to start of construction.
2.3	Potential for delays or rejection of anticipated County procured permits: local Critical Areas Ordinance permits (Bellevue, Issaquah, Renton, and King County), SEPA (King County), Shoreline Exemption (King County)	L	M	LM			$ -	Avoid properties/ areas that trigger permits Investigate all permits needed Begin permit acquisition process early in formal design.
2.4	Other unanticipated permits are required and delay project, such as Nationwide Permit (U.S. Corps of Engineers), 401 Water Quality Certification (Ecology), and/or Hydraulic Project Approval (WDFW)	L	H	LH			$ -	Avoid properties/ areas that trigger permits Investigate all permits needed Avoid work in areas which trigger Federal and State permits.

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
3.0	**Environmental / Public Impact**							
3.1	Unexpected hazardous materials encountered during excavation and/or dewatering activities results in project delays and unanticipated disposal costs	L	L	LL			$ -	Do as thorough as job as possible gathering info regarding property profile Avoid work in areas which have greater potential for hazardous materials
3.2	Potential spills, emissions, or violations occur during construction	L	L	LL			$ -	Hire contractors who place safety as a priority Include explicit requirements in specifications for control of spills and emissions during construction.
3.3	Changes to environmental regulations after NTP	L	L	LL			$ -	This is highly unlikely if NTP is within the time frame of a valid permit
3.4	Identification of potential Environmental issue that were not identified during the design phase.	L	L	LL			$ -	Do as thorough as job as possible gathering info regarding environmental characteristics of property Avoid work in areas where the likelihood of these types of discoveries is high.
4.0	**Engineering / Design**							
	I/I is not uniformly distributed across basins as assumed; and reduction targets are not achieved in the basin (Bellevue & Issaquah)	M	H	MH	30%	$ 1,571,250	$ 471,375	Add additional meters in the basin in smaller areas and monitor the flows. Mitigation - work in additional basins to get a greater I/I reduction. Determine during design if this would be cost effective approach. Contingency - arrange I/I contract to do unit price work to increase the amount of work if needed.
4.1	Skyway	M	H	MH	30%	$ 1,367,500	$ 410,250	Planning - continue to monitor and model flows during design phase to gain more comfort with flows. Planning - continue to compare I/I project to capital project during design to check for cost effectiveness. Planning - assume multiple phases, over several years, for construction so that flows can be checked as the work proceeds. Does this work with KC budget? Obtain sufficient ROE's to allow for addition of properties to reach reduction targets.
	I/I removal targets in basins are achieved; however, a lesser reduction rate at the location of the downstream CSI project is realized because additional flows enter the system from other tributary areas (Bellevue & Issaquah).	M	H	MH	30%	$ 1,571,250	$ 471,375	Perform more metering throughout the basin and refine the model. Mitigation - work in additional basins to get a greater I/I reduction. Determine during design if this would be cost effective approach. Contingency - arrange I/I contract to do unit price work to increase the amount of work if needed.

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
4.2	Skyway	H	H	HH	50%	$ 1,641,000	$ 820,500	Planning - continue to monitor and model flows during design phase to gain more comfort with flows. Planning - continue to compare I/I project to capital project during design to check for cost effectiveness. Planning - assume multiple phases, over several years, for construction so that flows can be checked as the work proceeds. Does this work with KC budget? Obtain sufficient ROE's to allow for addition of properties to reach reduction targets. Skyway could have lower level of service.
4.3	Peak I/I rates have been over-estimated in a basin selected for implementation. Following rehabilitation, target reductions are not achieved (Bellevue & Issaquah)	M	M	MM	30%	$ 1,257,000	$ 377,100	Perform more metering throughout the basin and refine the model. Mitigation - work in additional basins to get a greater I/I reduction. Determine during design if this would be cost effective approach. Contingency - arrange I/I contract to do unit price work to increase the amount of work if needed.
	Skyway	L	M	LM			$ -	Planning - continue to monitor and model flows during design phase to gain more comfort with flows. Planning - continue to compare I/I project to capital project during design to check for cost effectiveness. Planning - assume multiple phases, over several years, for construction so that flows can be checked as the work proceeds. Does this work with KC budget? Ensure modeling results have been verified with real world rainfall and flow measurement data.

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
4.4	Rise in groundwater levels as a result of a reduction in I/I may require resizing of existing surface drainage systems (ditches, inlets, etc.) due to increase in seepage/spring volumes.	M	L	ML			$ -	Build some storm work into project cost up to 10 properties. Planning - document drainage complaints before I/I construction and monitor after construction, for at least the warranty period, especially in Skyway. Planning - look at the existing drainage systems during design to see how the systems are configured and what connections or changes could be made if a groundwater problem did arise due to I/I rehab work. Also look for houses with basements or steep slopes where increases in groundwater levels increase risks. Transfer - let storm drainage agency know about I/I project and tell them to expect complaints and that they may need to deal with the drainage issues. Contingency - set aside money to make improvements to a storm drainage system on private property to fix the problem after it occurs. (Could involve french drains, piping, and creation of easements across a neighbors property.) Avoid work in areas of surface drainage elements which convey seeps/springs.
5.0	**Construction / General and Subsurface Site Conditions**							
5.1	Rehabilitation product or implementation issues arise during construction; requiring a large change order to change product requirements or means and methods of project implementation.	L	M	LM			$ -	Utilize well established construction products and methods for proposed project.
5.2	Drainage issues arise on multiple private properties resulting from I/I removal that require resolution as part of the project; increasing project costs.	M	L	ML				Update project construction cost estimates at regular intervals during design to reflect market conditions.
5.3	Slope stability issues arise on multiple private properties resulting from I/I removal that require resolution as part of the project; increasing project costs.	L	M	LM			$ -	Identify properties with increased risk of surface drainage impacts and account for potential mitigation in construction cost estimates.
5.4	Soil erosion issues arise on multiple private properties resulting from I/I removal that require resolution as part of the project; increasing project costs.	L	M	LM			$ -	Avoid work in areas that have a high probability of slope instability. Put II in storm sewer.

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
5.5	Inability to control groundwater causes pipe installation to stop.	L	M	LM			$ -	Avoid work in areas where the likelihood of these types of discoveries is high.
5.6	Construction dewatering during excavation activities may result in localized ground settlement, which could damage existing structures or facilities.	L	M	LM			$ -	This is trenchless construction - groundwater is probably not much of an issue in the pits. (It was not a problem in the Skyway pilot basin.) Avoid work in areas where the likelihood of these types of discoveries is high.
5.7	Soil and groundwater conditions different than anticipated may reduce effectiveness of constructed dewatering system resulting in delays and additional costs.	L	M	LM			$ -	Should be almost no dewatering because of minimal amount of excavation, mainly doing pipe bursting. Define project to avoid sensitive area. Avoid work in areas where the likelihood of these types of discoveries is high. Mitigation - can avoid work in areas with fish windows or can easily schedule around the windows. Construction scheduling has a lot of flexibility, including KC budget timing.
5.8	Construction is delayed or is limited to certain months due to fish and wildlife windows.	L	M	LM			$ -	Should be almost no dewatering because of minimal amount of excavation, mainly doing pipe bursting. Avoid work in areas where the likelihood of these types of discoveries is high. Need Exploration to understand conditions
5.9	Improper construction leading to more drainage complaints after the completion of the project.	L	M	LM			$ -	Avoid work in areas where the likelihood of these types of discoveries is high. I/I rehab work is unlikely to cause problems, mainly because pipe bursting requires so little excavation. Ensure specifications provide for adequate testing and verification to avoid poor construction.
5.10	Construction drawings don't accurately show sewers or side sewers and construction problems occur.	L	M	LM			$ -	Mitigation - plan on these issues occurring and make contractor responsible for CCTV of all pipes before construction. Add bid item for extra pipe location work. Planning - work with homeowners during design to see if they can help locate sewers - they often know where the pipes are on their property.
5.11	Problems with utility conflicts	L	L	LL			$ -	There is some potential for other utilities to be in the way of excavation for pipe bursting pits.
5.12	Claims from property owners	M	L	ML			$ -	Likely and difficult to argue against. Easiest claims to deal with are obvious, such as the the damaged tree or blocked sewer.

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
5.13	Bypass pumping problems	L	H	LH				Bypass pumping can be problematic for contractors depending on the amount of flow in the pipe. Mainly sewer main issue. Somewhat less of a problem for side sewers. Planning - make the bypass specifications clear on requirements and make clear how important bypassing operations are to the work.
5.14	I/I rehab construction finds many inflow sources that are problematic to fix	L	L	LL				
5.15	Coordination issues between cities/districts and King County.	L	M	LM				Develop relationship with city/district staff during design and get inspectors involved during design. Example is keeping in touch with Skyway's inspector during the pilot project.
5.16	Inspectors are unfamiliar with pipe bursting or other rehab methods	L	M	LM				Think about how to find or train inspectors in construction methods before construction starts.
6.0	**Contracting Issues / Materials, Equipment and Labor**							
6.1	High Bids	M	M	MM	15%	$ 1,400,000	$ 210,000	- Pick Bid Timing - Bid marketing/ advance notice to contractors - Prequalify Structure bid packages to allow for release of smaller packages to more contractors if necessary
7.0	**Public Relations/Community Action**							
7.1	Community rallies against perceived surface water risks.	L	L	LL			$ -	Keep on radar 1. Work closely with local jurisdiction regarding surface water issues during design phase. 2. Look at E&P discussions on this topic for issues to be considered. 3. Identify any known problem areas. 4. Avoid areas with known surface water problems. 5. Develop supplemental stormwater/drainage information materials.
7.2	Property owners don't understand the project or the relationship of the Local Agency and WTD.	H	L	HL			$ -	* Produce clear and comprehensive public information materials and provide to communities by mail, at open houses and via the project website. * Ensure local agencies reviews these materials. * Ensure County and local elected are briefed on project and receive materials in advance, in case they are the ones contacted by property owners. * Hold informal open houses with Q&A sessions co-sponsored by County and local agency (or at least with local agency representation) where community members can become informed and ask questions.

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
7.3	Members of project team communicate incorrect or incomplete information to the public.	L	M	LM			$ -	* Prepare all members of project team who will be interacting with public to provide accurate verbal and written information, at team meetings. Review communication protocols at regular intervals during team mtgs.. * Hold a briefing for contractors before they go into the field and at regular intervals throughout construction to review the communications protocol and highlight information they need to be looking at in the database and maps, including right of entry issues. Familiarize contractors with public information materials; provide copies for them to hand out to public.
7.4	Community members perceive that side sewer work is not equitably distributed.	H	L	HL			$ -	* Project team is clear in materials, at information sessions and other communications that King County can legally only work on side sewers expected to be cost-effective at reducing downstream flow.
7.5	Mailings are sent to the wrong addresses, leading people to become unnecessarily distressed about potential work on their property or disappointed when they learn they are not candidates for side sewer rehabilitation.	M	L	ML			$ -	Visual confirmation of map of mailing addresses versus project area map. Confirm that GIS staff can generate maps from address lists. QC protocol for mailing lists established. 1.Ensure adequate staff resources are available for ROW acquisition and roles and responsibilities are clearly defined. 2. ROW and CR team members work together to create QA/QC protocol for mailings lists 3. Work with GIS to create map of mailing addresses prior to each mailing.
7.6	Project team member communicates with community member without regard to previously communicated special needs (e.g. language needs) or concerns. Community member does not build trust with project team/King County.	M	L	ML			$ -	1. Develop and beta test communications database to ensure it provides the tool we need. 2. Develop clear project communication protocols and review at regular intervals with project team and contractors. 3. Follow mitigation measures in 8.3 4. Identify person(s) responsible for entering and tracking public comments.
7.7	Community perceives that their concerns were not addressed during design/construction.	M	L	ML			$ -	* Track comments properly, as described in 8.6. * Ensure project team takes public input into account in project design and execution. * In all informational materials, open houses, other communications with public, ensure County's decision making process is explicitly described. * Once decisions are made regarding what properties to work on, create public information pieces that describe these decisions and how public input was taken into account.
7.8	After warranty period for construction ends residents contact KC community relations and report surface water problems.	M	L	ML			$ -	

TABLE 4.2

Risk Identification		Risk Qualification			Risk Quantification			Risk Mitigation / Response
Risk #	**Description of Risk Event**	**Probability**	**Impact**	**Rating**	**Probability**	**Impact (dollars)**	**Risk Cost**	**Description**
7.9	Property owners expect more mitigation/restoration than the County is willing to or legally able to provide.	H	L	HL			$ -	* Document preexisting conditions clearly, including developing guidelines for preconstruction digital photos. Include these guidelines in contractor scopes of work. * Be clear in all communications what the County can and cannot do in the way of mitigation and restoration.
8.0	**Safety and Security**							
8.1	Damage to public or private property due to improper construction techniques and practices.	L	M	LM			$ -	1. Contingency - should set aside some money to deal with major backups. Minor backups should be the responsibility of the contractor. 2. Ensure specifications provide for adequate testing and verification to avoid poor construction, and provide adequate inspection as work progresses to eliminate the establishment of practices leading to damage.
9.0	**Policy Related External Risks**							
9.1	Schedule is delayed for political or budgetary reasons.	M	M	MM			$ -	
9.2	State auditor or AG rules against KC's use on available funds on private property.	M	H	MH			$ -	
9.3	Local jurisdiction political leaders or management removes support for project.	L	H	LH			$ -	
						TOTAL RISK COSTS:	**$ 3,193,640**	