DRAFT
Inglewood Basin Plan

Prepared for

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BIBI	benthic invertebrate index
CIP	Capital Improvement Project
City	City of Sammamish
Ecology	Washington State Department of Ecology
GMA	Growth Management Act
gpm	gallons per minute
KCC	King County Code
LID	Low Impact Development
msl	mean sea level
NPDES	National Pollutant Discharge Elimination System
RCW	Revised Code of Washington
RM	river mile
SEPA	State Environmental Policy Act
SMC	Sammamish Municipal Code
UGA	urban growth area

EXECUTIVE SUMMARY

This plan provides an update to a previous basin planning effort conducted in 2005. The Inglewood Basin is one of two basins located at the headwaters of the proposed Sammamish Town Center. The purpose of this basin update is to update existing natural and built conditions that may have changed since 2005 and to consider potential impacts resulting from development of the Town Center. Previous studies have included this basin, beginning in 1995 with King County's East Lake Sammamish Basin and Nonpoint Action Plan and again in 2005 with the completion of the Inglewood Basin Plan.

The Inglewood Basin is in fair condition with respect to some characteristics, such as quality of wetlands and riparian forest adjacent to George Davis Creek, and large areas of recessional outwash geology that serves as an underground reservoir and collection system for surface water runoff. However, it is impaired with respect to fish habitat and access. There are three fish passage barriers located within 1/2 mile of Lake Sammamish that prevent fish use of upstream habitat.

Specific features that define the Inglewood Basin and are important considerations in the development of projects and strategies are as follows:

Geology—The underlying geology in the Inglewood Basin consists of compacted till and highly infiltrative recessional glacial outwash. The outwash serves a very important function in this basin, serving as a gigantic subsurface reservoir that recharges deeper groundwater aquifers and supplies flow to George Davis Creek and associated wetlands. It is important to minimize development of impervious surfaces on these highly infiltrative areas to protect the groundwater recharge capacity.

Wetland—There are very high quality, large wetlands in the Inglewood Basin that provide hydrologic functions of storing water and attenuating flood flows as well as providing diverse habitat for birds and other wildlife species. It is important to protect these areas for their critical functions.

Fish Passage Barriers—There are at least three fish passage barriers on George Davis Creek within the first 1/2 mile of Lake Sammamish. Despite relatively good fish habitat, these barriers represent a costly and unlikely restoration of anadromous fish populations to the lower reaches of George Davis Creek. For this reason, the removal of these barriers is not recommended as part of this plan.

The projects and strategies recommended below are designed to preserve ecological function in areas that are currently functioning well, solve existing problems, and prevent future degradation as the Inglewood Basin is further developed (Table ES-1). The cost of these projects is about $350,000, not including property acquisition, if required.

Table ES-1. Matrix of Recommended Projects

Strategy	Project Identification	Type of Strategy: Planning	Type of Strategy: Education	Type of Strategy: Capital	Description	Potential Partners	Cost	Priority
Rehabilitate and Enhance Wetland 1509	Enh-1			X	Restore/enhance pasture area in Wetland 1509	Private property owners, developers in need of potential mitigation, conservancy groups	$164,000	High
Conduct Wetland Tours	Ed-1		X		Sponsor wetland tours to foster appreciation and stewardship of Sammamish Wetlands	Audubon Society, non-profit environmental groups	$6,000	Low
NE 217th Street Road Drainage Modification	CIP-1			X	Improve road drainage to reduce flooding to neighboring residence.	None	$59,000	Low
228th Avenue NE Stormwater Discharge Modification	CIP-2			X	Modify stormwater outfall discharge from 228th Avenue NE to reduce erosion and saturated conditions.	None	$55,000 - $78,000	Medium
NE 2nd Street Culvert Replacement	CIP-3			X	Replace culverts at NE 2nd Street driveway.	None	$40,000	Medium

1. INTRODUCTION

This plan provides an update to a previous basin planning effort conducted in 2005. The Inglewood Basin is one of two basins located at the headwaters of the proposed Sammamish Town Center. The purpose of this basin update is to update existing natural and built conditions that may have changed since 2005 and to consider potential impacts resulting from development of the Town Center. Previous studies have included this basin, beginning in 1995 with King County's East Lake Sammamish Basin and Nonpoint Action Plan and again in 2005 with the completion of the Inglewood Basin Plan.

1.1 BASIN PLANNING CONTEXT

The goals of this basin plan are to identify stormwater and surface water-related projects and strategies that (1) protect existing natural resources, (2) restore or enhance ecological or surface water functions where they are impaired, and (3) prevent future degradation of natural resources from future development. The City's Comprehensive Plan (City of Sammamish 2003) provides the impetus for completing basin plans:

> "The City shall provide Basin Plans for all areas of the City by either adopting existing plans or creating new ones, to assure that permitted development will not degrade the surface or ground water resources." (Goal ECP-1.27)

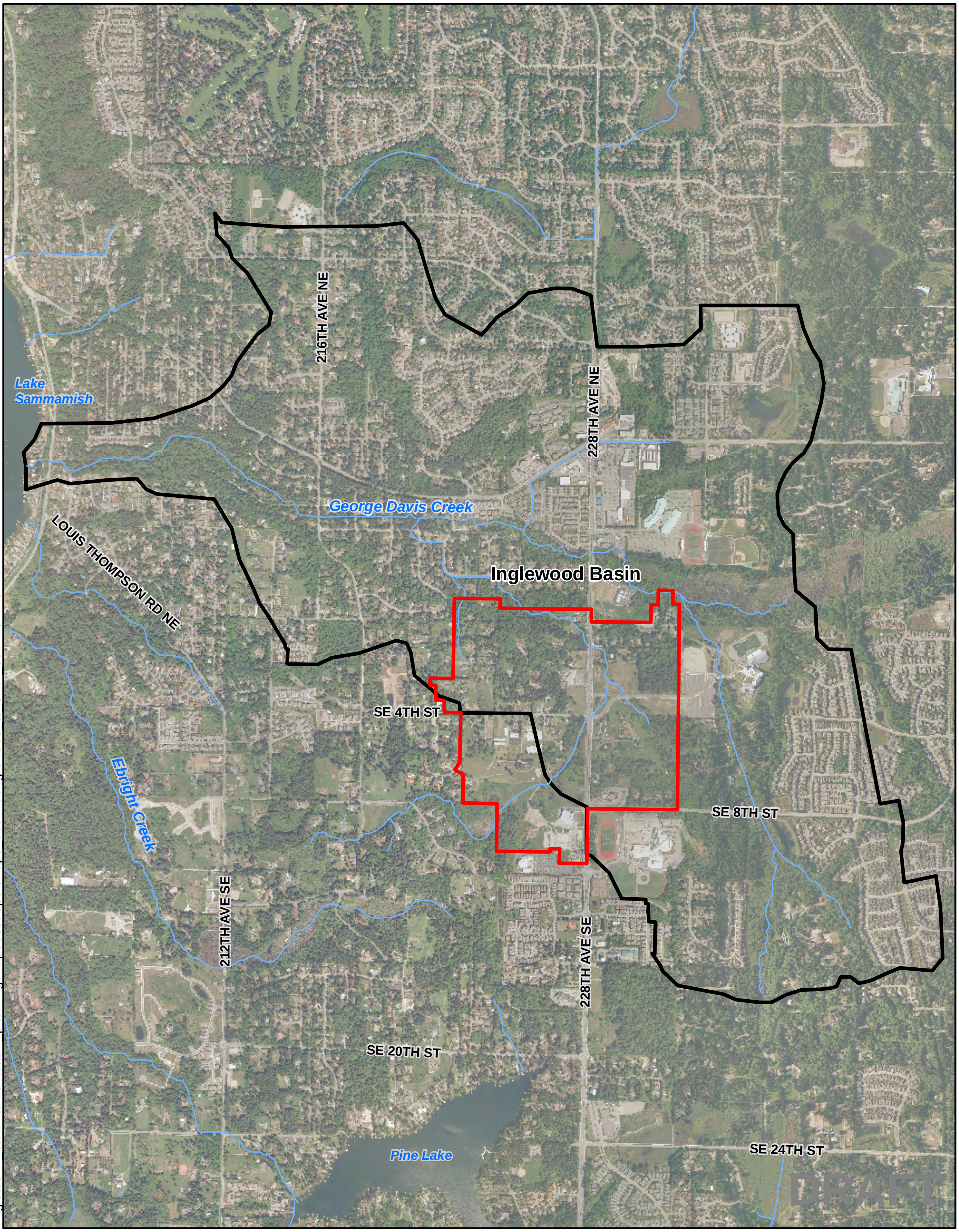
Additionally, the City has many environmental goals in the Comprehensive Plan (City of Sammamish 2003) that relate directly to basin planning efforts, including:

> **"**Preserve and enhance the natural features and historic, cultural and archeological resources of the community." (Goal LUG-9)

> **"**Preserve trees and other natural resources as integral components of the community's overall design." (Goal LUG-10)

> **"**Practice environmental stewardship by protecting, enhancing, and promoting the natural environment in and around the City." (Goal EC-1)

> **"**Maintain a surface water and groundwater system that serves the community, enhances the quality of life, and protects the environment." (Goal EC-3)



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Scale in Feet

Inglewood Basin

Sammamish Town Center

Figure 1
Inglewood Basin

These City goals, as well as regulatory directives, such as the City's National Pollutant Discharge Elimination System (NPDES) Phase II permit, and public safety issues such as flooding and access to clean water, provide the framework for development of the Inglewood Basin plan (Figure 2).

Figure 2. Basin Plan Framework

In general, this basin plan is organized into sections based on the community and regulatory framework and what is know (review of previous documentation, results of the Parametrix field investigation and hydrologic modeling), followed by recommendations that are consistent with the City's goals and policies to address existing and potential future watershed concerns. Specific projects and strategies to address watershed concerns were developed into stand-alone projects that can be implemented through the City's Capital Improvement Project (CIP) program.

2. COMMUNITY AND REGULATORY FRAMEWORK

The City of Sammamish governs land use, stormwater, and the use of natural resources through codes and ordinances that are specific to the City or dictated by overarching state and federal regulations. These regulations, along with the City's vision to "blend small town atmosphere with suburban character" and maintain "quality neighborhoods, vibrant natural features, and outstanding recreational opportunities," result in several overlapping policies and goals regarding the management of stormwater and natural resources in the Inglewood Basin. Table 1 summarizes existing federal, state, and local regulations related to stormwater runoff and natural resources and the relevance of these regulations to the Inglewood Basin.

Table 1. Regulatory Framework of Surface Water Management in the Inglewood Basin

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Inglewood Sub-basin
Clean Water Act	Washington State Department of Ecology	National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Separate Storm Sewer System Permit	Eliminate discharge of pollutants into the nation's water, and achieve water quality levels that are protective of beneficial uses	The City of Sammamish is a NPDES Phase II permittee and must comply with conditions of the permit.
	Washington State Department of Ecology	Surface Water Quality Standards	Protect and regulate the quality of surface water in Washington State through (1) sustaining designated uses, (2) meeting numeric water quality criteria, and (3) implementing antidegradation policies	George Davis creek is listed on the State's 303(d) Category 5 list for water quality impairment by fecal coliform bacteria because of non-compliance with numeric water quality standards.
	Washington State Department of Ecology and U.S. Army Corps of Engineers	Sections 401 and 404	Requires a permit for activities classified by the U.S. Army Corps of Engineers for dredge or discharge of fill material to Waters of the United States	George Davis Creek and associated wetlands and tributaries, including Lake Sammamish, are considered Waters of the United States. In-water activities that meet minimum dredge and fill limits require a permit.
Tribal Agreements and Related Case Law	Muckleshoot or Snoqualmie Tribes		Protect fish populations in traditional fishing grounds of Native American Tribes	Snoqualmie and Muckleshoot Tribes are party to SEPA review of development proposals and programs within the Inglewood watershed.
Endangered Species Act	United States Fish and Wildlife Services and NOAA Fisheries in consultation with lead federal agencies		Prevent further decline of listed terrestrial and aquatic species, including Puget Sound Chinook salmon, steelhead trout, marbled murrelet, and other species.	Unknown status of endangered species in Inglewood Basin.
State Environmental Policy Act (SEPA)	The City of Sammamish conducts reviews and issues SEPA determinations on proposed projects within its jurisdiction		Identify and require mitigation of the environmental impacts of proposals and programs	SEPA is used to address impacts on projects in the Inglewood Basin that are not covered in other City code requirements.
Shoreline Management Act	City of Sammamish Shoreline Master Plan		Protect use and functions (economic, ecological, aesthetic) of shoreline areas	Only the part of the Inglewood Basin that borders Lake Sammamish is included in the City's Shoreline Master Plan.

Table 1. Regulatory Framework of Surface Water Management in the Inglewood Basin (continued)

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Inglewood Sub-basin
Washington State Hydraulic Code	Washington State Department of Fish and Wildlife		Sets requirements for placement of culverts and other hydraulic devices that may affect fish use	Projects within ordinary high water mark of streams must obtain a Hydraulic Project Approval permit from WDFW. Culverts must be fish passable where fish are present.
Growth Management Act (GMA)	City of Sammamish implements GMA	City of Sammamish Comprehensive Plan, Sammamish Town Center Plan	Regulate land use to meet growth targets while providing necessary services and protecting sensitive environmental resources	The Inglewood Basin is located in a designated urban growth area within the City of Sammamish.

2.1 CITY OF SAMMAMISH SURFACE WATER CODE AND REQUIREMENTS

The City's surface water code (Sammamish Municipal Code [SMC] §15.05.010), through adoption of King County's 1998 Surface Water Design Manual and code (King County Code [KCC] §9.12.035), outlines stormwater management requirements for new development and redevelopment projects that meet certain size thresholds within the City's jurisdiction. This is the primary regulatory mechanism for managing stormwater. The City is in the process of updating its code to include adoption of the latest King County Surface Water Design Manual (2009) or the Washington State Department of Ecology's 2005 Stormwater Management Manual for Western Washington (2005 Ecology Manual), as required by the City's Phase II NPDES permit.

The City of Sammamish adopted a Low Impact Development (LID) Ordinance (02008-236) in 2008. This ordinance is based on incentives and encourages development proposals to incorporate LID techniques in exchange for increased density, signage, publicity, and other incentives.

In addition to adoption of a stormwater management manual that is consistent with the 2005 Ecology Manual, the City's NPDES Phase II permit outlines several stormwater management requirements related to water quality, including:

- Public education;
- Illicit discharge detection and elimination programs;
- Public involvement and participation;
- Construction and development runoff control; and
- Municipal operation and maintenance.

The City already has many of these stormwater management components in place and is currently updating its stormwater management approach to comply with NPDES Phase II permit requirements. The NPDES program requirements will affect the Inglewood Basin in the following ways: updated stormwater management requirements for new development; opportunities for developers to obtain special allowances in exchange for utilizing LID techniques; increased maintenance frequency for City stormwater infrastructure; and continued public involvement and education regarding stormwater issues.

2.2 CITY OF SAMMAMISH COMPREHENSIVE PLAN

The Comprehensive Plan was adopted in 2003 and updated in 2006. It was developed in accordance with the state Growth Management Act's planning goals (Revised Code of Washington [RCW] 36.70A.020), which includes encouraging growth in urban areas where City services will be provided, limiting sprawl, protecting the environment and natural areas, and encouraging the involvement of citizens in the planning process. The Inglewood Basin is located entirely within the City's UGA. The Comprehensive Plan outlines several goals associated with each planning element. The goals related to surface water management and basin planning are summarized in Table 2 showing how these goals relate to existing City regulations.

Table 2. Relationship of Comprehensive Plan Goals to Existing City Regulations and Programs

	Elements of Comprehensive Plan Goals Related to Stormwater Management									
City Codes and Regulations	**Preservation of Natural Environment/Open Space**	**Encourage Non-traditional Alternatives to Stormwater Management**	**Environmental Education**	**Protect Surface and Ground Water Resources**	**Minimize Impervious Surfaces**	**Integrated Water Resources Management**	**Use incentives, Regulations and Programs to Manage Water Resources**	**Enhance Water Quality**	**Protect Ground Water Recharge Quantity and Quality**	**Maintain Ecologic and Hydrologic Functioning of Natural Systems**
Critical Areas Ordinance	√			√					√	√
Growth Management Act	√									
LID Ordinance		√			√		√			
City/Town Center Stormwater Code		√		√	√	√				√
Shoreline Management Act	√									
NPDES Phase II Permit			√					√		

2.2.1 Town Center Plan

The Sammamish Town Center Plan was adopted in June 2008, outlining elements related to the development of 240 acres of property along 228th Avenue SE at the headwaters of the Inglewood and Inglewood basins. The elements in the Town Center Plan that relate to this basin plan include land use, open space, natural systems, and capital facilities and utilities. The Town Center Plan cites opportunities to "employ an integrated strategy to managing storm water and enhance the ecology" through "LID techniques to more closely emulate the natural hydrology" and "coordinate storm water management through an integrated regional system." A separate Comprehensive Stormwater Master Plan was prepared for the Town Center (Parametrix 2009a); design strategies for the Town Center will also be briefly discussed in this plan.

2.2.2 Critical Areas Ordinance

Several designated critical areas are located within the Inglewood Basin, including landslide and erosion hazard areas on the flanks of George Davis Creek on the west slope of the Sammamish Plateau, wetlands, streams, wildlife corridors, and critical aquifer recharge areas (Figure 3). Approximately one-half of the entire basin is designated as a critical area. The City's Critical Areas Ordinance (No. 02005-193) and Environmentally Critical Areas Code (SMC Chapter 21A.50) specify activities allowed and prohibited in these areas, as well as requirements for mitigating impacts to critical areas. In addition to the Critical Areas Code that applies to the entire city, a special wetland overlay area has additional requirements and include portions of the Inglewood Basin. The Critical Areas Code is important to basin planning because it outlines requirements related to surface water runoff and management through development restrictions adjacent to erosion hazard areas, limitations on impervious surface construction in critical aquifer recharge areas, and wetland and stream buffers to keep riparian areas and wildlife corridors intact.

2.3 CITY OF SAMMAMISH SHORELINE MASTER PROGRAM

The City's waterbodies that are considered shorelines of the state include Lake Sammamish, Pine Lake, and Beaver Lake. None of the streams located within the basin limits, including George Davis Creek, is large enough to be included in the Shoreline Master Program. The Inglewood Basin does include a very small portion of the Lake Sammamish shoreline. Parametrix did not evaluate shoreline conditions and implications of the Shoreline Master Program for the Inglewood Basin.

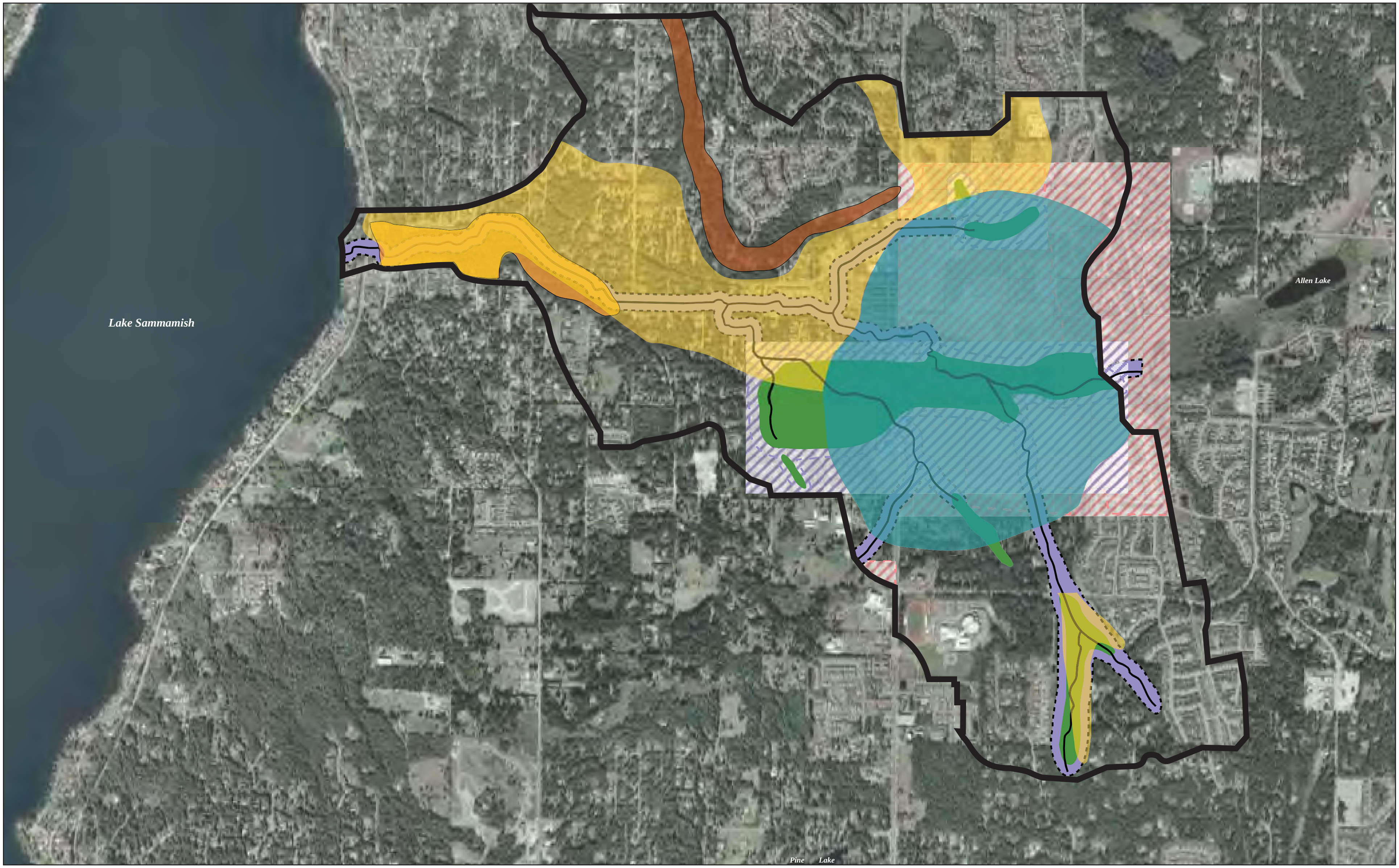
2.4 SEATTLE AND KING COUNTY PUBLIC HEALTH DEPARTMENT

The Seattle and King County Public Health Department regulate drinking water sources, including surface water developed for water supply, and drilled wells using groundwater as a source of potable water. Additionally, the health department helps to ensure that septic systems are installed and operating properly. The commercial area in the Inglewood Basin at the intersection of Inglewood Hill Road and 228th Avenue SE receives sanitary sewer service from the Sammamish Plateau Water and Sewer District, however, most of the basin is still relies on private septic systems. Parametrix did not investigate whether there have been any water quality or quantity concerns from private well owners, or whether private sewer systems are properly functioning.

2.5 WATER AND SEWER DISTRICTS

Most of the Inglewood Basin is within the Sammamish Plateau Water and Sewer District service area, however a very small portion on the north side is in the Northeast Sammamish Sewer and Water District service area. As mentioned above, large areas of the basin are still on private sewer systems, but the District's plan is to construct future mains and lift stations to service the basin (Sammamish Plateau Water and Sewer District 2003). As the area gets redeveloped, new water lines will also likely service those residents that are currently on private well systems.

The District operates 13 municipal water wells in the vicinity of the city limits. These wells range in depth from 134 feet bgs to 955 feet bgs for a total capacity of approximately 7,000 gallons per minute (gpm) (Department of Health Water Facilities Inventory 2000).



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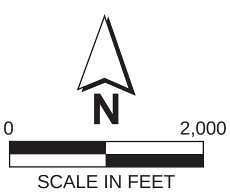


- Subbasin
- Stream
- Wetland
- Wetland Buffer
- Landslide Hazard
- Erosion Hazard Areas
- Stream Buffer
- Critical Aquifer Recharge Area

Figure 3
Inglewood Basin Critical Areas

3. WATERSHED CHARACTERISTICS

Existing watershed characteristics were evaluated through review of previous studies and documentation, aerial photographs, maps, and field reconnaissance that included walking the stream channels and visiting wetlands in the basin. Additionally, supplemental information was obtained from residents at public meetings held in December 2008 and March 2009. Physical stream channel attributes collected in the field along with existing land use, future zoning, and geologic data were used to develop a hydrologic model of the basin to evaluate existing and future surface water flow conditions.

The Inglewood Basin is in fair condition with respect to some characteristics, such as quality of wetlands and riparian forest adjacent to George Davis Creek, and large areas of recessional outwash geology that serves as an underground reservoir and collection system for surface water runoff. However, it is impaired with respect to fish habitat and access. There are three fish passage barriers located within 1/2 mile of Lake Sammamish that prevent fish use of upstream habitat. Table 3 summarizes existing conditions, potential future impacts, and existing regulatory measures in place to ensure protection of natural resources.

The watershed threats in the Inglewood Basin are primarily related to the conversion of land to rural and suburban uses, particularly development over areas of recessional outwash. If the basin is built out to its full zoning potential, this could represent an increase in impervious surfaces from 15 percent to 32 percent.

3.1 PHYSICAL SETTING

The Inglewood basin is located on the east side of Lake Sammamish in east King County, Washington. The sub-basin is approximately 2.6 square miles in size, with an elevation range of 615 feet above mean sea level at the top of the Sammamish Plateau, to an elevation of 40 feet above mean sea level at the mouth of George Davis Creek (George Davis Creek is the primary drainage feature in the Inglewood sub-basin) in Lake Sammamish. Approximately 32 percent of the sub-basin is forested, with much of the forested area located in the riparian corridor adjacent to George Davis Creek. Impervious surface is roughly 15 percent of the total area based on average assumed impervious surface coverage for the different land types in the sub-basin. Road density in the basin in about 10.4 miles/sq. mile, fairly high for the level of development in the basin.

Table 3. Summary of Existing Conditions and Future Impacts

	Watershed Characteristic	Existing Conditions	Potential Future Impacts	Existing Regulatory Measures to Ensure Protection
Biological Characteristics	**Fisheries**	Aquatic habitat is in fair condition, but limited by stream flow and access. Stream flow is present in the winter months, much of George Davis Creek is dry during the summer and fall.	Unlikely that future development will significantly affect habitat. Flows are attenuated through infiltration into the recessional outwash.	Critical Areas Ordinance (CAO)—150- foot stream buffer on George Davis Creek.
		Complete fish passage barriers exist downstream of East Lake Sammamish Trail, at East Lake Sammamish Parkway, and upstream at an old concrete dam located about 1/2 mile upstream of the parkway.		CAO—Subdivisions must place wildlife corridors (such as George Davis Creek) in a contiguous permanent open space tract.
		Large woody debris has been placed in the channel as restoration, likely to prevent sediment movement, rather than create fish habitat.		
	Wetlands	Several large depressional wetlands, with groundwater hydrology and seasonal flooding. Some wetlands and buffers are degraded from residential development; others are in fairly good shape.	Vegetation and hydroperiod changes from increased stormwater runoff or infiltration; encroachment from urbanization.	CAO—Wetland buffers vary from 50 to 215 feet depending on wetland category.
		Many wetlands in the Inglewood Basin have been encroached upon by development and have resulted in wetland fragmentation.		CAO—Wetland special district overlay (180) requires a max. impervious surface area of 8% in areas zoned R-1 within special overlay. Some portions of Inglewood Sub-basin are within this overlay.
		Wetlands receive more flow now with increased development (anecdotal information). Trees have been dying due to longer periods of saturation in some areas.		CAO—Surface water discharges are allowed in wetlands and their buffers only if the discharge does not increase rate of flow, decrease water quality, or change plant composition.
	Riparian Corridor	Fairly good condition in vicinity of George Davis Creek.	Encroachment from development, change in size and type of vegetation (smaller trees, less dense).	CAO—Wetland and stream buffers (see above) and vegetation management plan for clearing done in critical areas
				50% of sites must retain trees or re-vegetate with trees in areas zoned R-1 within wetland special overlay area.
Chemical Characteristics	**Water Quality**	George Davis Creek is on 303(d) list as a Category 5 impaired water body for fecal coliform bacteria.	Unknown; there isn't a continuous flow of water in the creek, and infiltration of surface water likely removes fecal coliform bacteria.	

Table 3. Summary of Existing Conditions and Future Impacts (continued)

	Watershed Characteristic	Existing Conditions	Potential Future Impacts	Existing Regulatory Measures to Ensure Protection
Physical Characteristics	**Groundwater Hydrology**	Several domestic groundwater wells in the Inglewood Basin.	Reduction in groundwater elevations in shallower aquifers due to more impervious surfaces and less groundwater recharge.	CAO—Much of Inglewood Sub-basin is located within critical aquifer recharge areas. 75% of on-site stormwater generated from new development must be infiltrated in these areas, unless not feasible.
		Groundwater recharge occurs in undeveloped portions of the basin at quite high rates depending on surface geologic conditions.		CAO—Some activities are prohibited in critical aquifer recharge areas to protect groundwater quality.
	Surface Hydrology	Surface water hydrological conditions relatively intact. Much of the Inglewood Basin has very high infiltration rates in the recessional outwash, which attenuates flows in the stream channel.	Increased flows, durations, and volumes from new development could overwhelm capacity of outwash or impact wetlands.	King County Title 9—Surface water management code adopted by City of Sammamish, Level 3 flow control match 100-year peak for predeveloped forest conditions.
	Hillslope Geomorphology	Lower reaches of George Davis Creek are within an erosion hazard area. Many landslides were observed adjacent to George Davis Creek; some may be due to residential surface water discharges.	Removal of vegetation or discharge of stormwater near the slopes of George Davis Creek could compromise slope conditions and cause additional landslides.	
Built Environment	**Impervious Surface Coverage**	Currently, approximately 15 % total impervious in basin.	Impervious surface estimates for future land use is 32% of basin.	CAO—Wetland overlay limits impervious to 8% in areas zoned R-1.

3.2 LAND USE AND POPULATION

Population on the Sammamish Plateau grew by nearly 600 percent between 1970 and 2001 (City of Sammamish 2003). Parametrix reviewed historical aerial photographs from 1944, 1970, 1979, 1996, 2002, and 2009. The 1979, 1996, 2002, and 2009 photographs are shown in Figures 4 through 7. The basin was very rural and mostly forested in the 1979 aerial photograph. Some residential and commercial development took place in the north portion of the basin (north of Inglewood Hill Road and at the intersection of Inglewood Hill Road and 228th Avenue SE) between 1979 and 1996. Significant land conversions have occurred since 1996 with the construction of two large high schools on 228th Avenue SE and several residential communities in the southeast part of the basin.

The Inglewood Basin is not built out based on existing zoning (Figure 8). The proposed Town Center includes more than 150 acres in the Inglewood Basin, some of which will be converted to dense development. Additionally, there are some areas zoned R-4 and R-6 (four and six dwelling units per acre, respectively) that are currently forested or developed at a rural density. These areas are likely to be built out and could result in stormwater and surface water impacts, particularly in those areas adjacent to wetlands, such as near Eastside Catholic High School, and steep slopes adjacent to George Davis Creek on the west slope of the plateau.

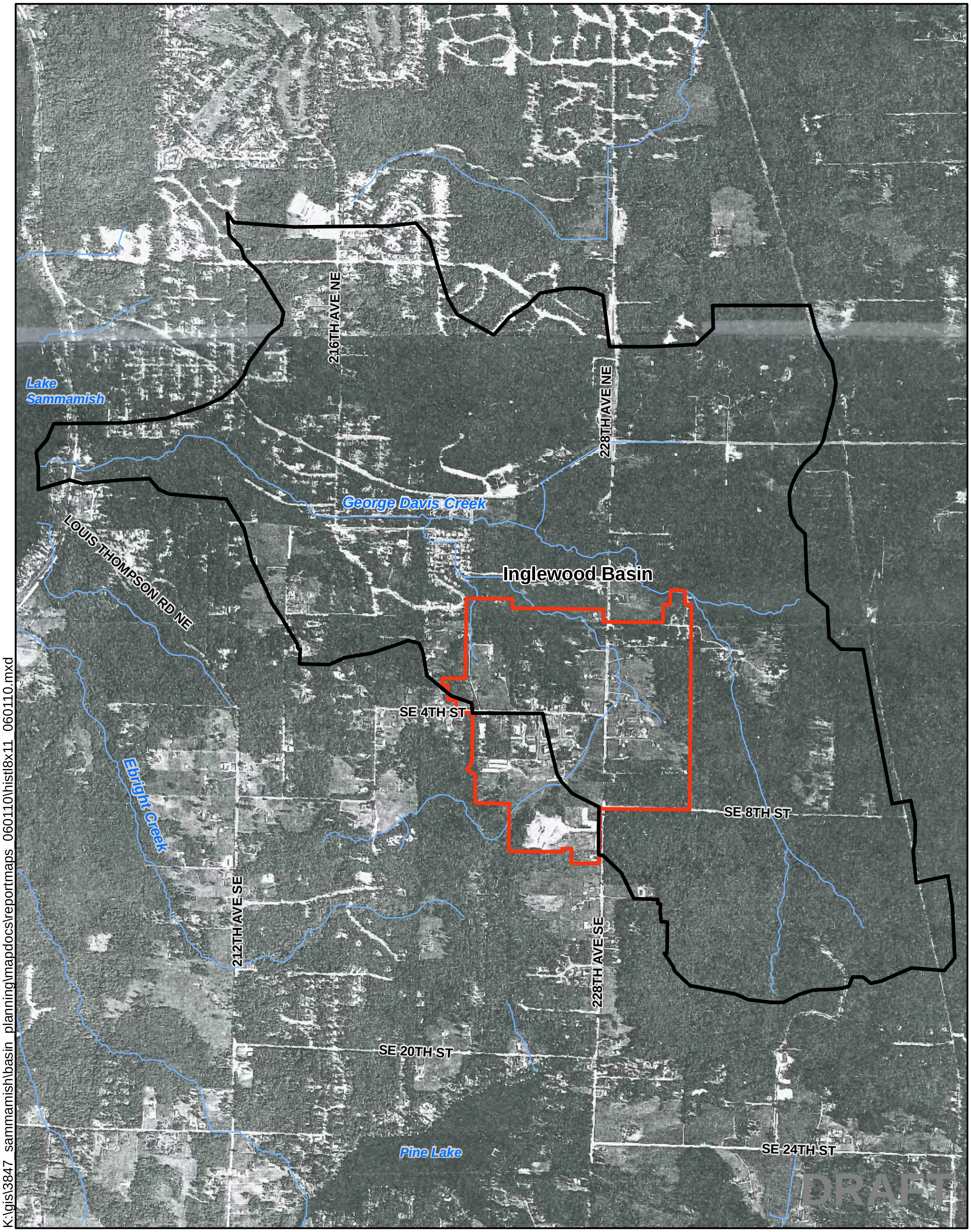
3.3 GEOLOGY AND GROUNDWATER

3.3.1 Geology

The geological features of the East Lake Sammamish Plateau have been mapped by Derek B. Booth and others at the U.S. Geological Survey (USGS 2006). A map of the basin surface geology is presented in Figure 9. Cross sections showing approximate subsurface geologic conditions were developed based on water well logs obtained from Washington State Department of Ecology (Ecology) and geotechnical studies available in unpublished reports (Hong West and Associates 1996; Nelson and Associates 1987, Terra Associates 1995, 1998, 1999). These cross sections are shown in Figures 10 and 11. The geological features are characterized by the following general sequence of unconsolidated glacial deposits from the surface downward:

- Vashon recessional outwash (Qvr);
- Vashon till (Qvt); and
- Vashon advance outwash (Qva); and
- Pre-Vashon undifferentiated unconsolidated deposits—glacial and non-glacial (Qpf).

Most of the upland areas of the Sammamish Plateau and the Inglewood Basin are mantled by Vashon Till (Qvt), a densely compacted poorly sorted mixture of boulders, cobbles, gravel, and sand in a matrix of silt and clay, often identified in driller's logs as "hardpan." The till is up to about 150 to 200 feet thick in some upland areas of the Sammamish Plateau based on a review of well records in the vicinity. The presence of till is an important consideration for stormwater management techniques because it is more difficult to infiltrate stormwater in these areas due to the compact nature and low permeability of the till.



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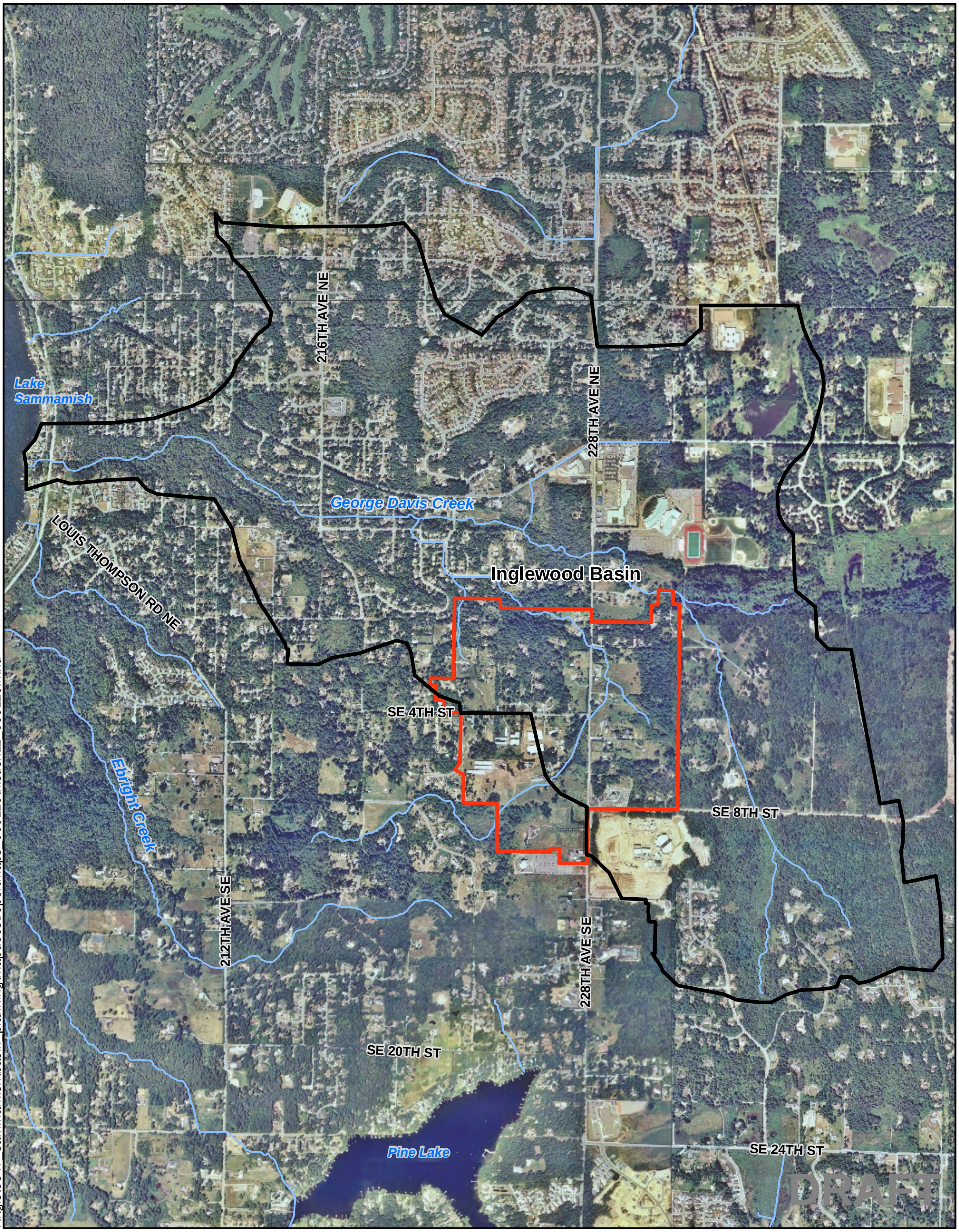
Scale in Feet

Inglewood Basin

Sammamish Town Center

Figure 4
Inglewood Basin
1979 Aerial Photography



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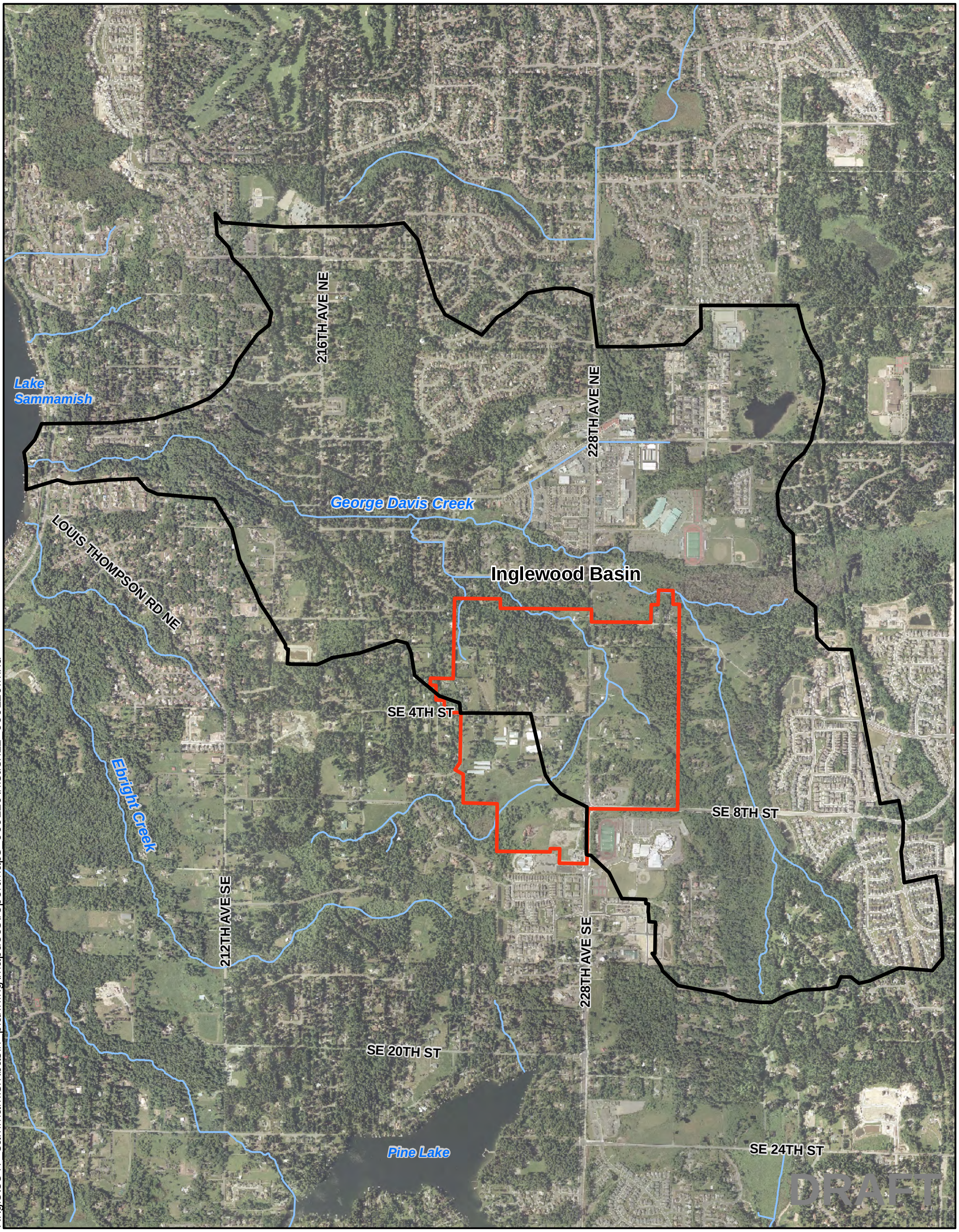
Scale in Feet

Inglewood Basin

Sammamish Town Center

Figure 5
Inglewood Basin
1996 Aerial Photography



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Scale in Feet

Inglewood Basin

Sammamish Town Center

Figure 6
Inglewood Basin
2002 Aerial Photography

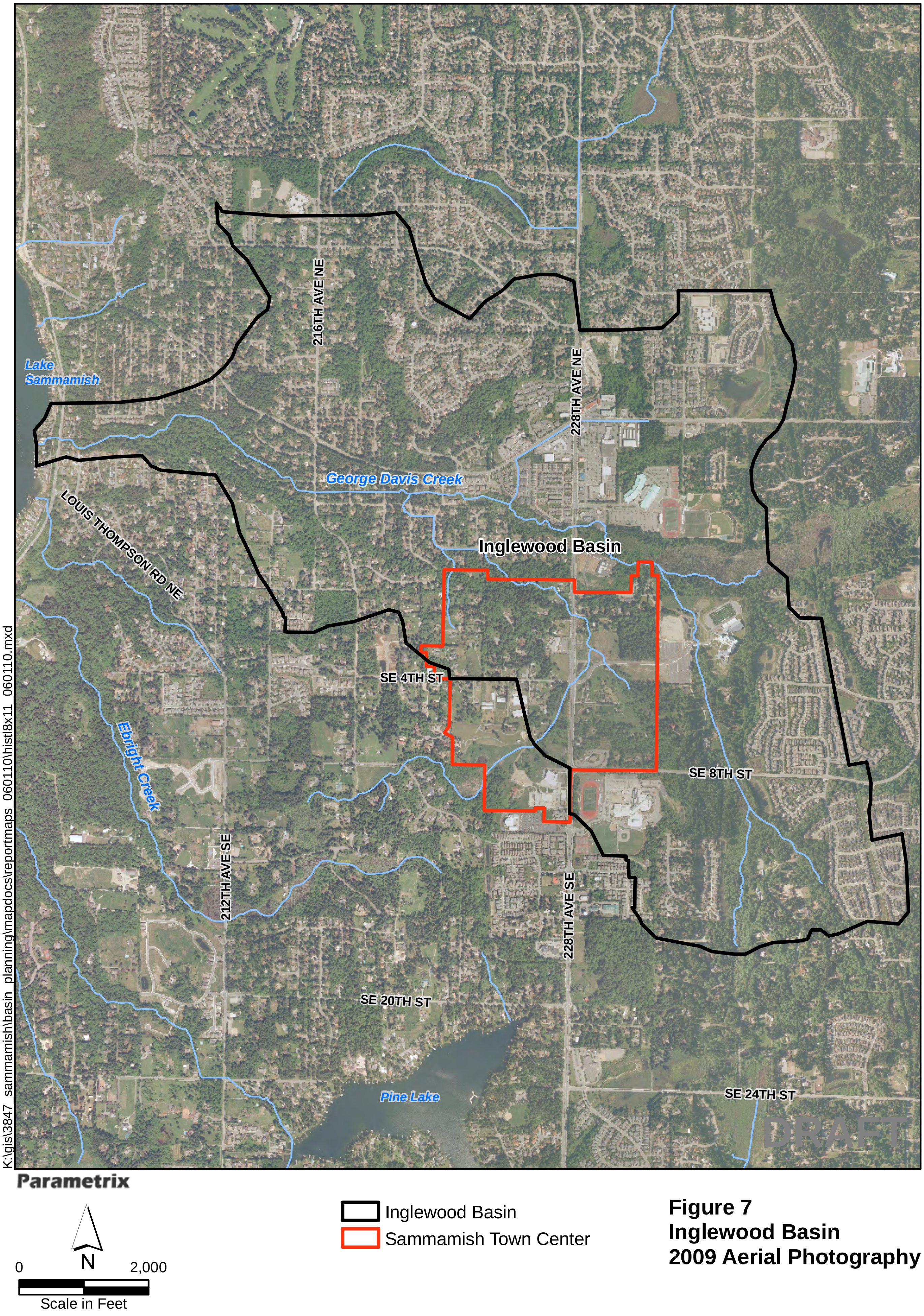
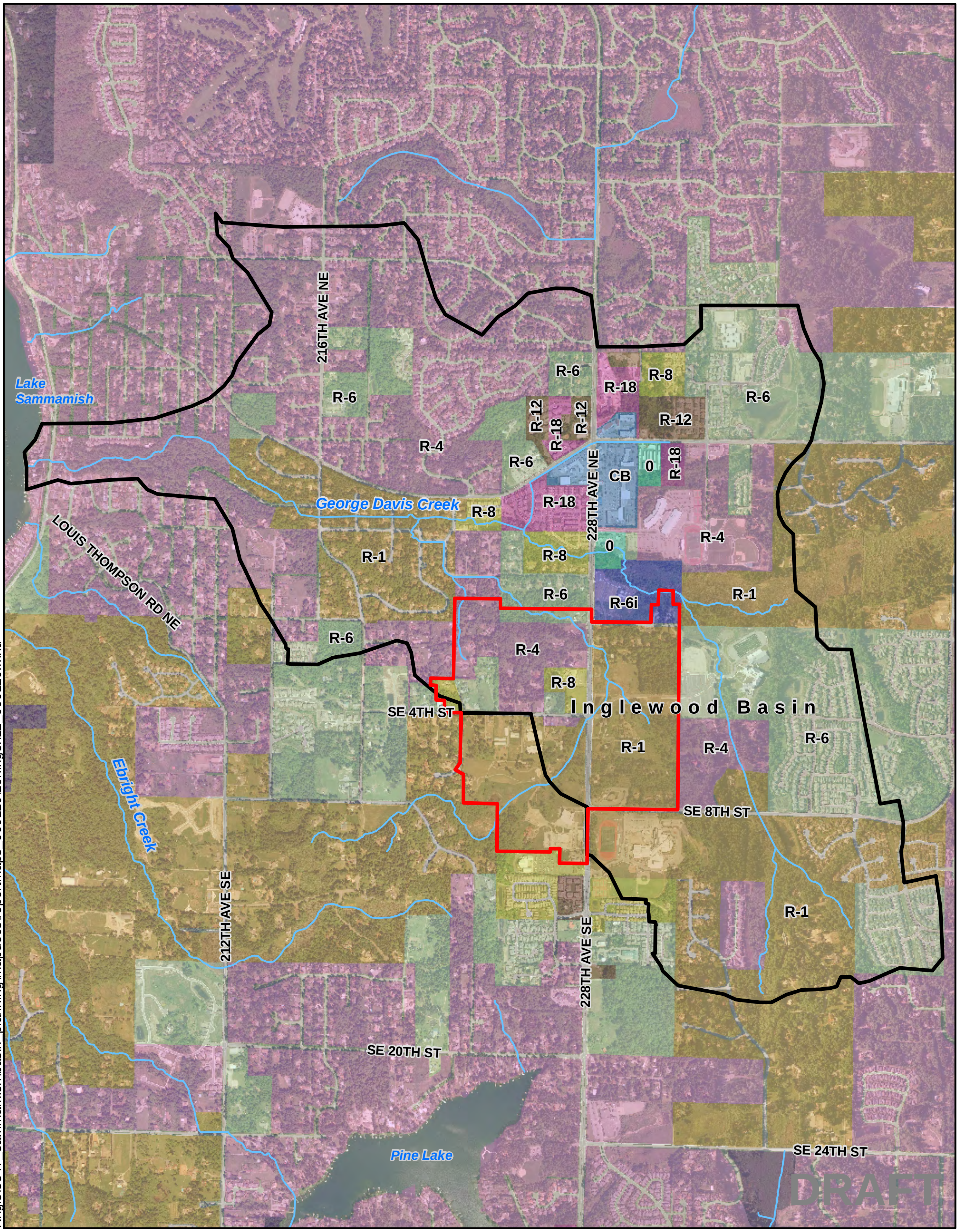


Figure 7
Inglewood Basin
2009 Aerial Photography



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Scale in Feet

Zoning

CB	R-1	R-4i		Inglewood Basin	
NB	R-12	R-6		Sammamish Town Center	
O	R-18	R-6i			
	R-4	R-8			

Figure 8
Inglewood Basin Comprehensive Plan Zoning

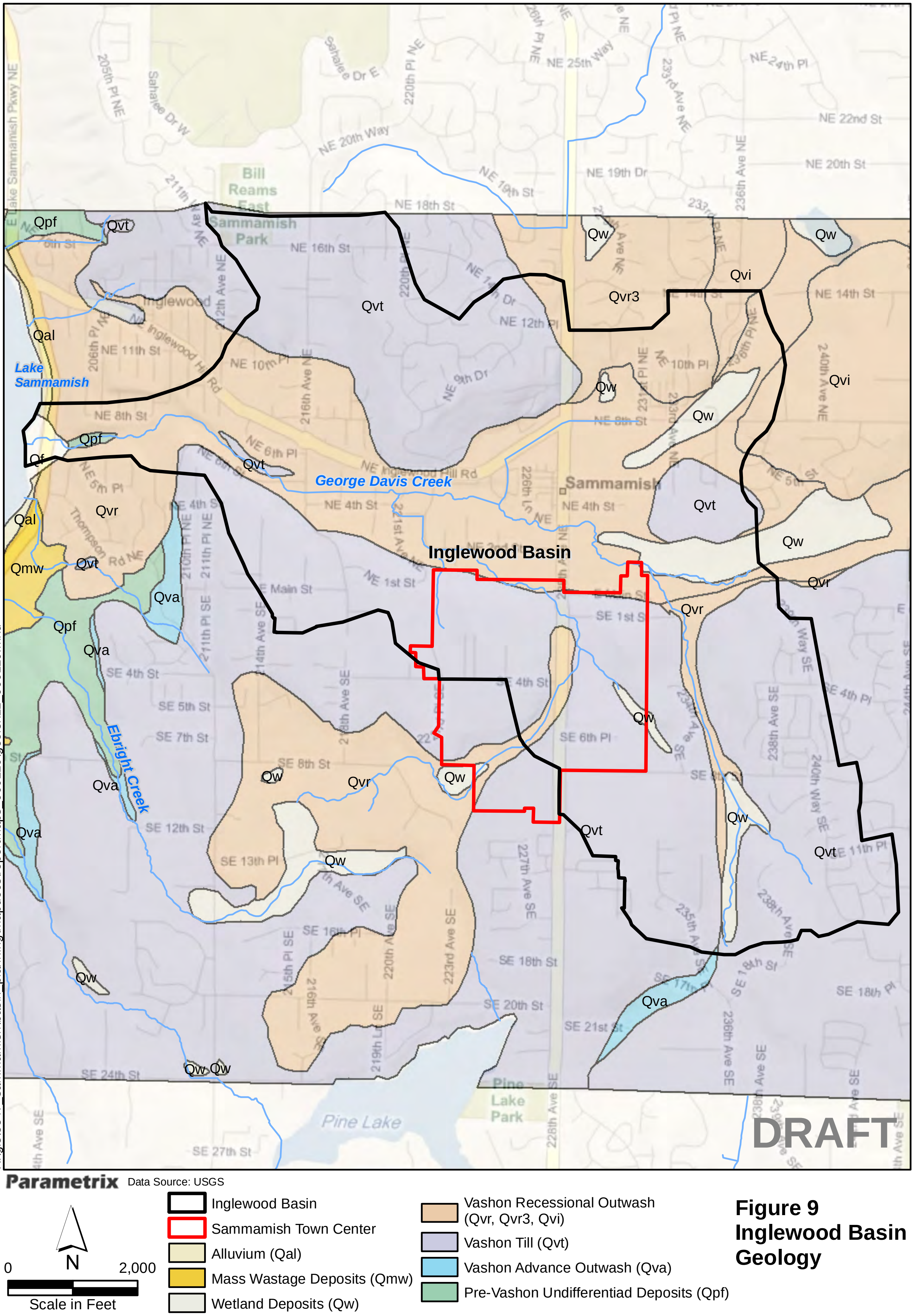

Figure 9
Inglewood Basin Geology

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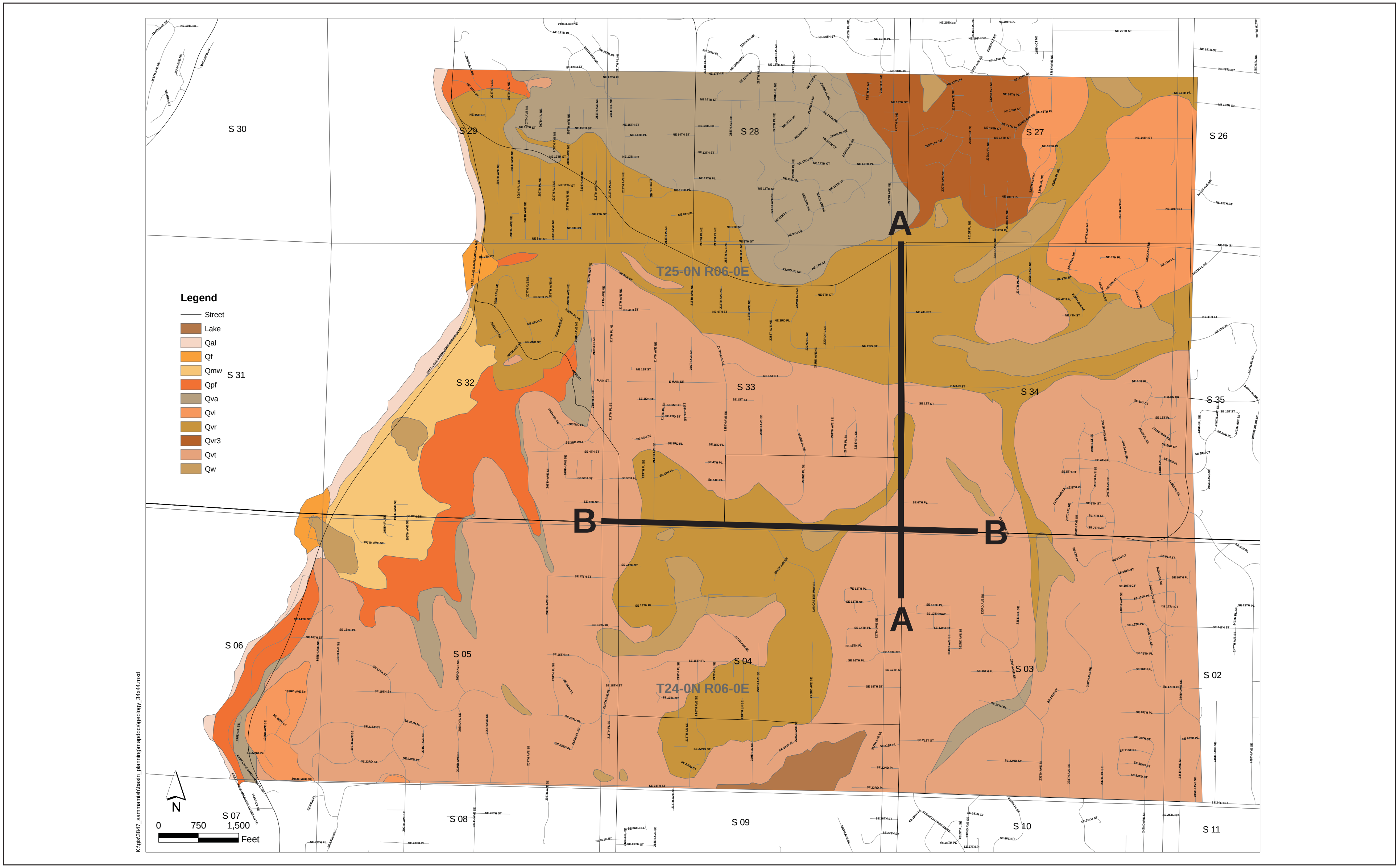

Parametrix 558-3847-002/01(07) 6/10 (B)

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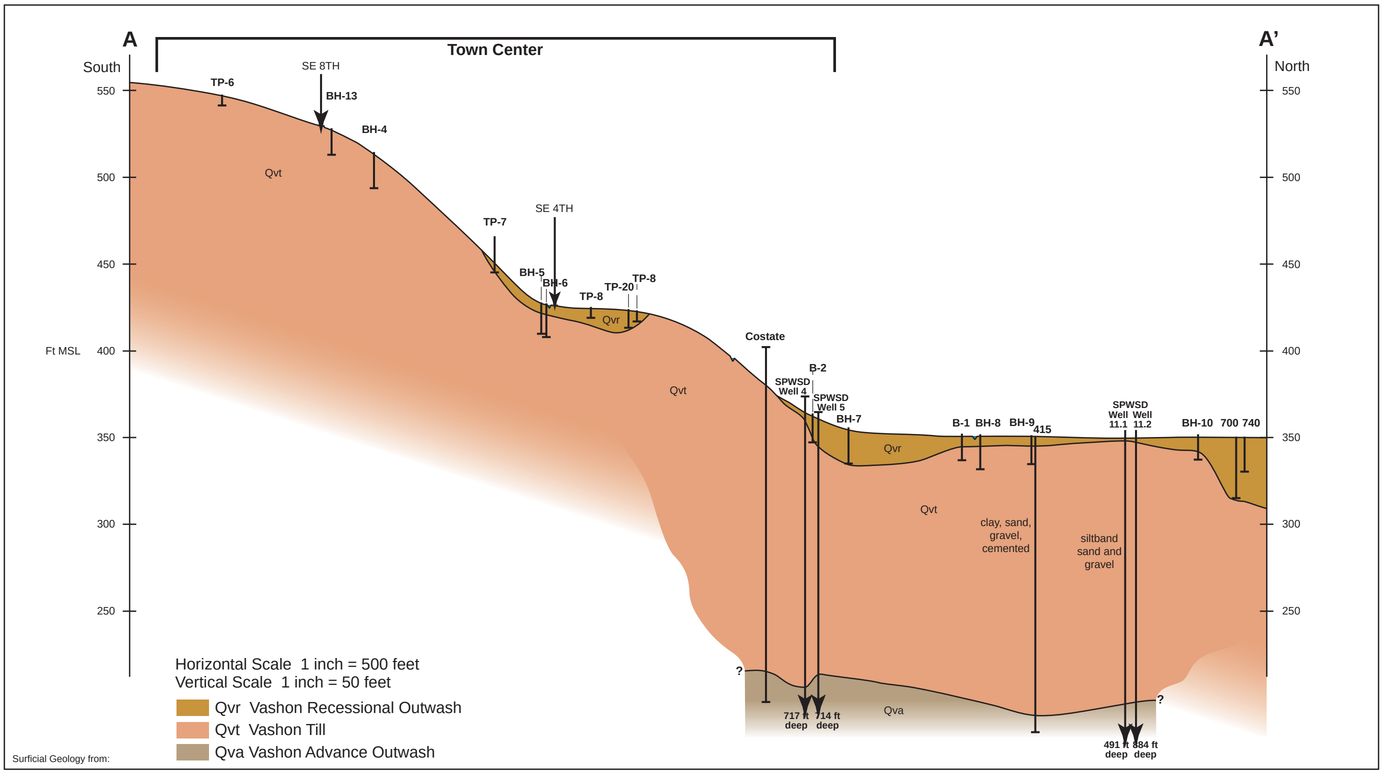
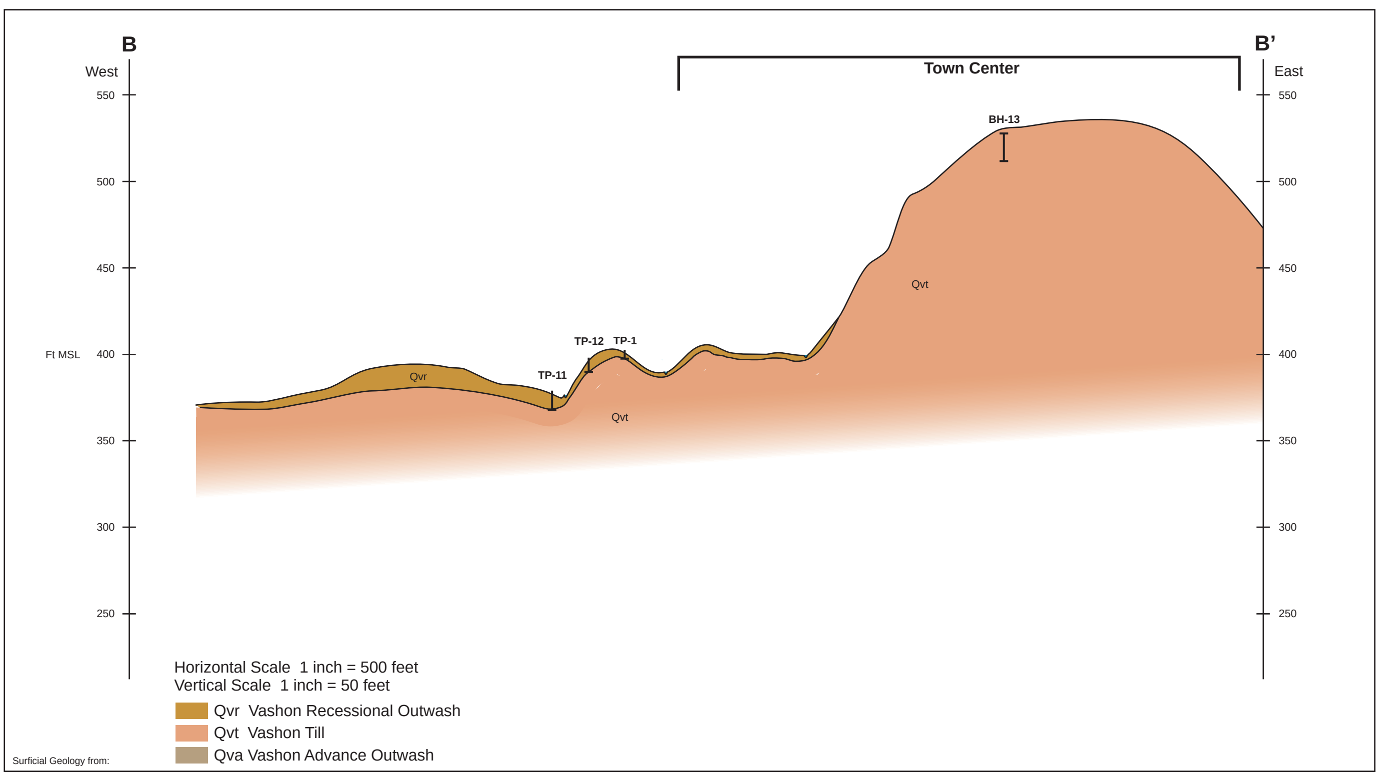
SCALE IN FEET

Figure 10
General Geology and Location of Geologic Cross Sections



Geologic Cross Section Along 228th Ave
City of Sammamish Town Center



Geologic Cross Section Along NE 8th Street
City of Sammamish Town Center

Figure 11
Geologic Cross Sections A-A' and B-B'

The Vashon Till is locally overlain by Vashon Recessional Outwash deposits (Qvr), a poorly sorted to well sorted, light gray, stratified gravel and sand with minor amounts of silt and clay deposited behind the receding glacier. The recessional outwash deposits are relatively thin on the south side of the Inglewood Basin (less than 20 feet) but get thicker toward the north (up to 50 feet or more). The recessional outwash is the surficial geologic unit present throughout the George Davis Creek corridor. It plays an important role in stormwater management in that it serves as a large underground reservoir for water and stormwater readily infiltrates where recessional outwash is present.

The Vashon Till is underlain by Vashon Advance Outwash (Qva) that consist of variably compacted sand and gravel deposited by streams and rivers ahead of the advancing glacier. Vashon Advance Outwash is typically variable in grain size, varying from silt to gravel and in sorting from well sorted to unsorted. The advance outwash is not exposed in the Inglewood Basin.

Pre-Vashon glacial deposits underlying the Vashon Advance Outwash include both glacial and non-glacial units. Two finer-grained and three coarser-grained units have been defined within these undifferentiated deposits.

Most of the surficial soils in the upland areas of the Inglewood Basin are mapped as Alderwood Series (Soil Conservation Service 1973) developed in the weathered Vashon Till and Everett soils developed in the recessional glacial outwash. The Alderwood soils are very gravelly sandy loam to very gravelly fine sandy loam and are typically moderately well drained, moderately deep, and are formed in glacial tills in upland areas. The Everett soils are somewhat excessively drained, and gravelly.

More recent surficial units mapped within the Inglewood Basin include:

- Alluvium (Qal);
- Wetland deposits (Qw); and
- Mass-wastage deposits (Qmw).

Wetland deposits (Qw) are mapped along small portions of the upper reaches of George Davis Creek, and are described as peat and alluvium, poorly drained and intermittently wet.

3.3.2 Groundwater Occurrence

Groundwater resources of the Sammamish Plateau are described in Turney et al. (1995) and Leisch et al. (1963). Precipitation provides the source of recharge to shallow aquifers in the upland areas of the Sammamish Plateau. Recharge in the project vicinity is estimated to be 10 to 20 inches per year in the till, and 21 to 30 inches per year in the recessional outwash (Turney et al. 1995). Groundwater flow in the upper units is locally influenced by variations in lithology. Deeper aquifers are recharged by downward movement from shallow aquifers and by lateral flow from regional recharge areas to the east. In the upper aquifers of the project vicinity, overall groundwater flow is westward toward Lake Sammamish.

Areas of the Inglewood Basin with Recessional Outwash mapped at the surface are designated as critical aquifer recharge areas in the Critical Areas Ordinance due to the permeable nature of these deposits. Although permeable, the relatively limited depths of the Recessional Outwash are not adequate to yield significant quantities of groundwater to wells. However, infiltration of precipitation through the Recessional Outwash provides an important source of recharge to underlying aquifers.

The upper part of the Vashon Till is typically more permeable than the lower part, and perched or semi-perched groundwater occurs locally within sand and gravel lenses. Wells completed in the till may yield small quantities of water that are adequate for domestic supply. The Vashon Advance Outwash yields a more reliable source of groundwater to some domestic wells in upland areas of the Sammamish Plateau completed at depths of approximately 100 to 300 feet.

Unconsolidated Pre-Vashon deposits underlying the Advance Outwash in the project vicinity provide the source of water supply to the City of Sammamish wells, completed at depths ranging from about 350 to 700 feet bgs, and elevations from 100 to less than -350 feet msl. Four wells are located in the Inglewood Basin along 228th Avenue (Wells 4, 5, 11.1, and 11.2), completed at approximate depths from 500 to over 700 feet bgs. Wellhead protection areas are designated in accordance with the Critical Areas Ordinance for each of the City wells. Water wells along East Lake Sammamish Parkway are typically less than 100 feet deep and many have artesian flow.

3.4 SURFACE WATER HYDROLOGY

The surface water hydrology of the Inglewood Basin is governed by rainfall rates, vegetative conditions (forest vs. grass), surface geology (permeable vs. impermeable geologic units), topography, and land development. Surface flow in the upper portion of George Davis Creek is seasonal, largely fed by groundwater supplied by the shallow recessional outwash aquifer. In the winter when water levels in the recessional outwash get high enough, local springs flow to George Davis Creek. Generally, the lower part of George Davis Creek (from about 212th Ave NE to the mouth) flows year-round. There are several large wetlands bisecting 228th Avenue SE, these wetlands serve to store a significant amount of surface water. The presence of the highly infiltrative recessional outwash and large wetlands likely attenuates flows to the stream channel.

Currently, the basin is approximately 15 percent impervious. There was only one localized runoff related problem identified in this basin. Runoff from 228th Avenue NE is currently discharged through an outfall near the top of the slope on the Westside of 228th Avenue NE. This discharge has caused erosion and also may be contributing to saturated conditions that have resulted in the death of several large fir trees in this area (Photograph 1). Additionally, two other drainage issues were identified:

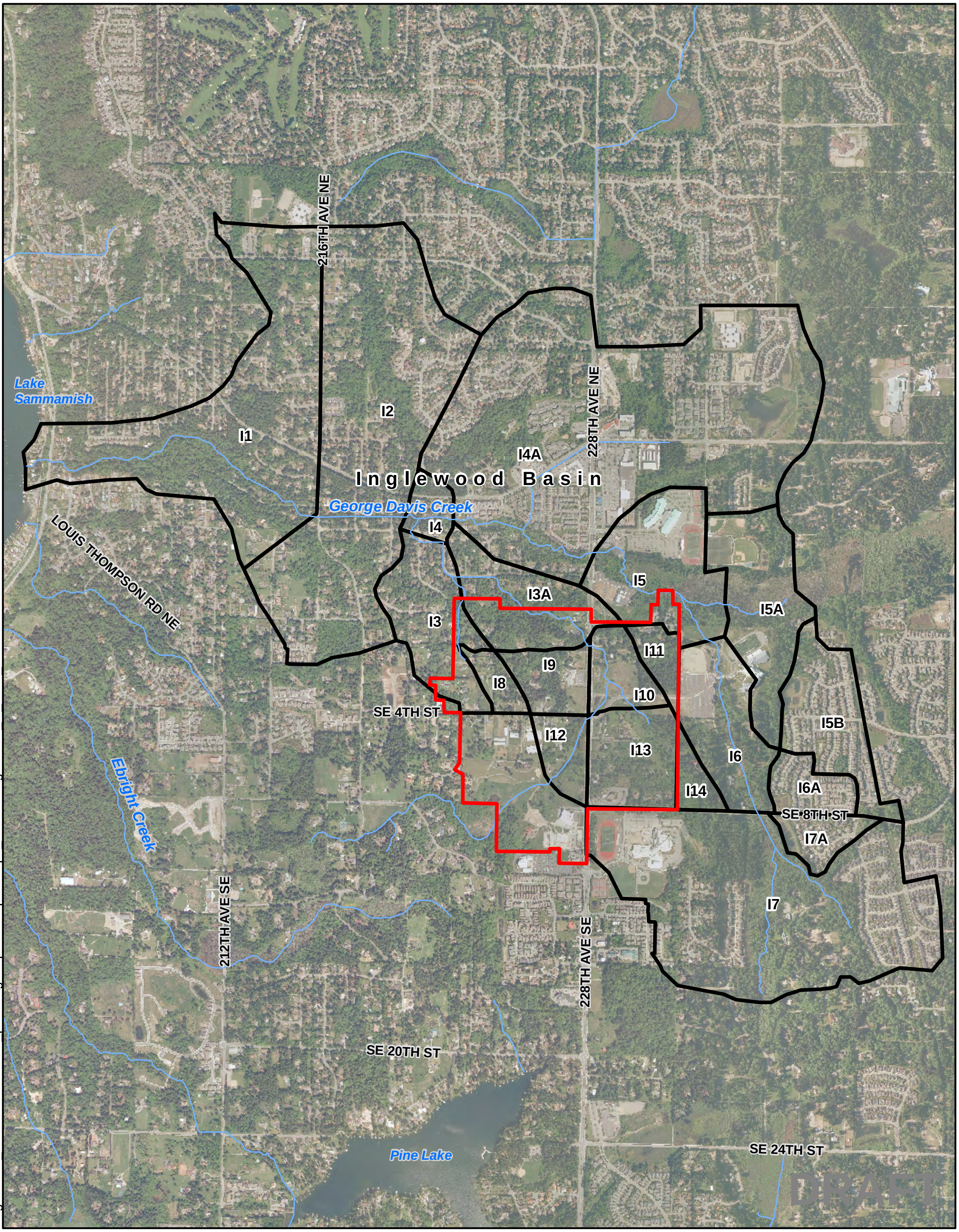
- Residential flooding on NE 217th Street
- Damaged culverts on NE 2nd Street

The NE 217th Street flooding was brought to the City’s attention by a local resident who experiences flooding from road runoff. The damaged culverts were identified during field visits by Parametrix. Capital projects to address these issues are described below in recommended strategies.

Photograph 1. Dying trees associated with saturated conditions on west side of 228th Avenue SE

3.4.1 Hydrologic Modeling

The surface hydrology of the Inglewood Basin was modeled using MGS Flood, an HSPF-based (Hydrologic Simulation Program Fortran) continuous hydrologic model. The basin was divided into 17 sub-basins for the purposes of modeling (Figure 12). Existing and future hydrologic conditions were modeled to evaluate existing and potential future impacts related to increased flow rates. Additionally, the existing and future flows were compared to conditions that would have existed in a pre-developed (forested) condition. Current City of Sammamish stormwater regulations require new development to match pre-developed conditions for the 2-year and 100-year peak flow rates. The modeling results indicate that with future stormwater mitigation, pre-developed peak flow conditions can be met with application of these stormwater management techniques. Figure 13 shows existing, forested, and future mitigated flows for the 2-year, 10-year, and 100-year peak flow rates. The complete modeling results are provided in Appendix A.



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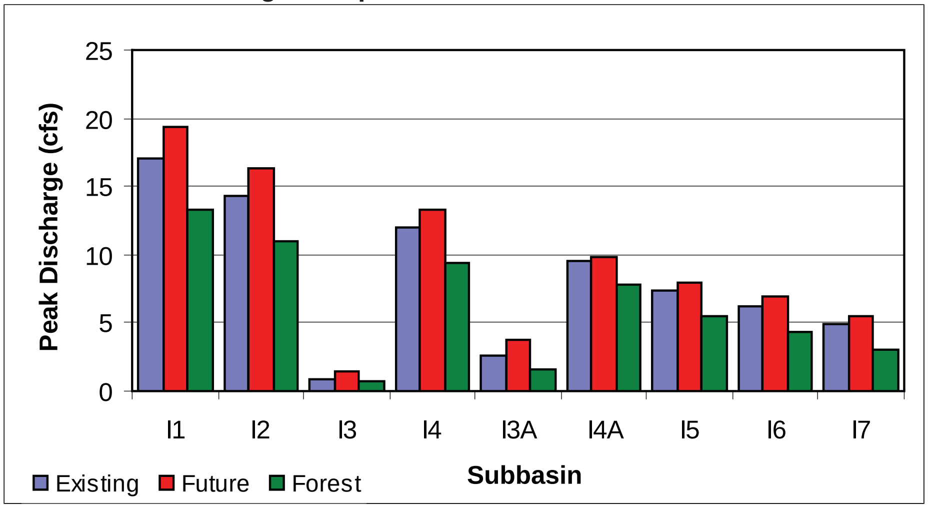
Scale in Feet

Inglewood Sub-Basins

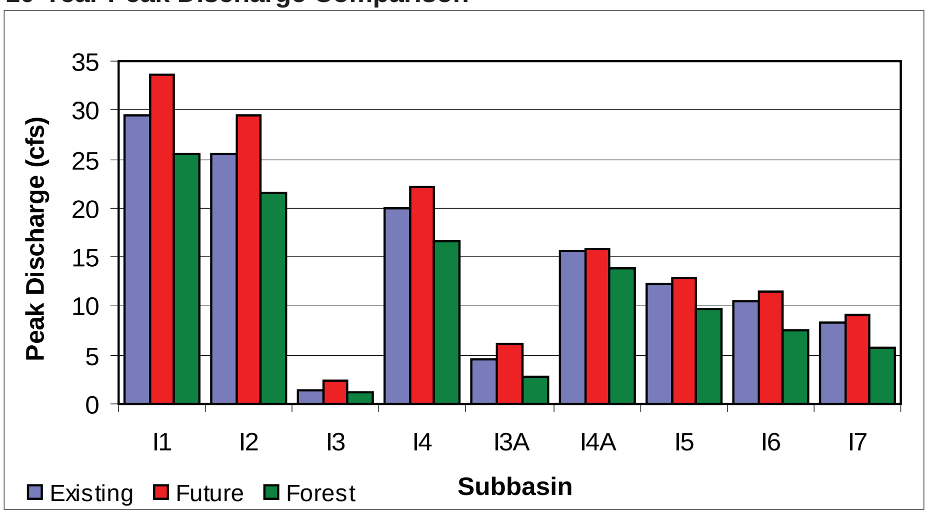
Sammamish Town Center

Figure 12
Inglewood Basin
Sub-Basins

2-Year Peak Discharge Comparison



10-Year Peak Discharge Comparison



100-Year Peak Discharge Comparison

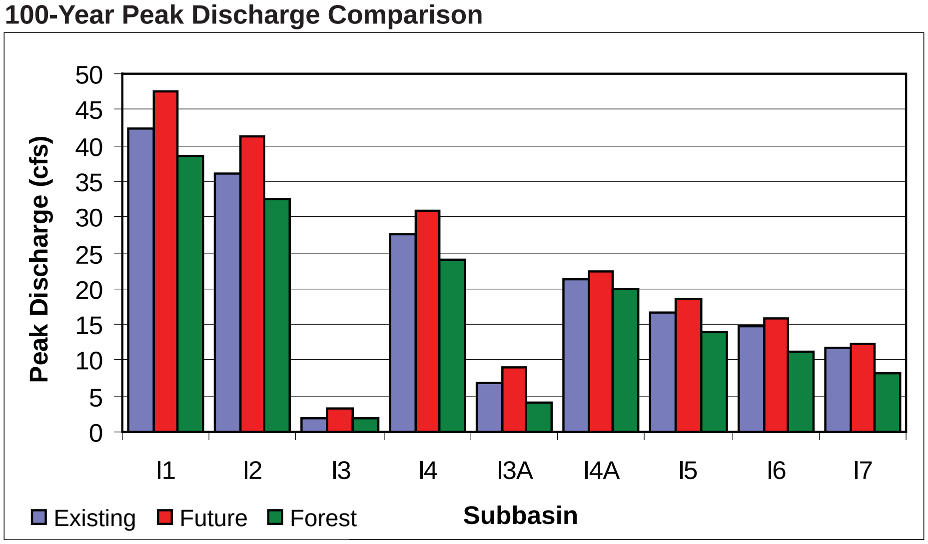


Figure 13
Inglewood Basin Hydrological Modeling Results

Whereas current stormwater requirements require management of flow rates and durations to minimize erosive forces in sensitive stream channels, they do not address increased stormwater volumes, which could affect wetland hydrology.

3.5 WETLANDS

Wetlands in the Inglewood Basin were evaluated by a limited field investigation from publically accessible sites. Wetlands were assessed in the field using a quick assessment method; a proper delineation would be necessary to confirm wetland classifications and ratings. Wetland data forms are in Appendix B. Prior to the field visit the following documents were reviewed:

- Inglewood Sub-Basin Plan (City of Sammamish 2005)
- City of Sammamish Town Center Sub-Area Plan DEIS (City of Sammamish 2007)
- Sammamish Stormwater Comprehensive Plan (City of Sammamish 2001)
- Wetland data on the City of Sammamish website
- National Wetland Inventory Maps

The eastern portion of the Inglewood Basin is located within the Town Center Special Study area. Most of the wetlands in the Inglewood Basin are located in the eastern portion of the sub-basin; therefore, most of the wetlands have been delineated and rated as part of the Town Center Sub-Area Plan. Wetland locations are shown in Figure 14. As stated in the Town Center Sub-Area Plan DEIS there may be unmapped wetlands on private properties. Wetlands in the Inglewood sub-basin are listed in Table 4 below; however, they are described in more detail in the Town Center Sub-Area Plan (City of Sammamish 2007).

The Inglewood Basin contains numerous wetlands and is dominated by a large wetland complex which begins in the Bear-Evans Creek Sub-Basin and continues west to approximately 222nd Ave just north of Main Street. As stated in the Town Center Sub-Area Plan DEIS (City of Sammamish 2007), this wetland complex is important for groundwater recharge, erosion and flood protection, and maintaining downstream water quality and fish habitat. Wetland 1509, the primary wetland in this complex is a Category I wetland and contains forested, scrub-shrub, and emergent vegetation classes as well as a bog or fen. Wetland 1511 is also rated a Category I wetland, this wetland contains forested, scrub-shrub, emergent and aquatic bed vegetation classes and provides excellent habitat due to its size and diversity and interspersion of habitats (Table 4).

Wetlands 13, 18, 1511, 1512, 1580B, 1509, SW 91, and SW 96 are all connected by George Davis Creek or its tributaries. Other wetlands in the basin may also be connected but their connections were not seen during limited site visits. Most of the smaller wetlands in the basin are depressional. Many of the wetlands are impacted by residential and other large developments.

Table 4. Inglewood Basin Wetlands

Wetland Name[a]	Approximate Size (acres)	Characteristics	Cowardin	Hydrogeomorphic Classification	Hydrology	Impacts	Mitigation Opportunities	Current Buffers	City of Sammamish (Quick Rating)
1509 (East Lake Samammish 1509)	150	Wetland complex with bog; headwater tributary to George Davis Creek; high value wildlife habitat; partially in the Bear-Evans Basin	Forested, scrub-shrub, emergent	Depressional	Surface water, seasonally flooded/saturated, permanently flooded/saturated	Residential development, pipeline	Enhancement	Forested and grass/lawn. Sammamish buffer is 215 feet	Category 1 (High)
1511 (East Lake Sammamish 11)	4.4	Wetland at headwater intermittent tributary to George Davis Creek; several man-made ponds	Forested, scrub-shrub, emergent	Depressional, slope	Surface water	Residential development	Restoration	Forested, herbaceous-native, grass-lawn. Sammamish buffer is 150 feet.	Category 1 (Moderate)
1577 (East Lake Sammamish 77)	1.6	Includes two headwater intermittent tributaries to George Davis Creek, site may be used by Pileated woodpecker	Forested, scrub-shrub, emergent	Depressional, Riverine, Slope	Surface water, seasonally flooded/saturated	Road		Forested, herbaceous-native, grass-lawn. Sammamish buffer is 100 feet.	Category 1 (special characteristics), Category II (functions) (Moderate)
1580B	1.1	Associated with intermittent tributary to George Davis Creek	Emergent	Depressional, Riverine, Slope	Surface water	Residential development, grazing/agriculture	Restore buffer	No buffer, Sammamish buffer is 50 feet	Category IV (Low)
SW91	0.03	Provides moderate habitat and water quality functions but no hydrologic functions	Emergenty	Slope	Not assessed	Not assessed	Not assessed	Sammamish buffer is 50 feet	Category IV
SW92	0.3	Has a diversity of habitats and possibly provides habitat for Pileated woodpecker	Forested, scrub-shrub, emergent	Depressional	Not assessed	Not assessed	Not assessed	Sammamish buffer is 50 feet	Category III
SW93	0.06	Provides moderate habitat value because of diversity of hydroperiods and vegetation. Part of a wetland complex associates with an intermittent stream.	Forested, scrub-shrub, emergent	Depressional	Not assessed	Not assessed	Not assessed	Sammamish buffer is 50 feet	Category III
SW94	0.4	Provides moderate habitat, water quality and hydrologic functions.	Forested, scrub-shrub, emergent	Depressional	Not assessed	Not assessed	Not assessed	Sammamish buffer is 50 feet.	Category III
SW96	0.01	Associated with intermittent stream.	Forested, scrub-shrub, emergent	Depressional	Not assessed	Not assessed	Not assessed	Sammamish buffer is 100 feet.	Category II
1502	>2	Provides excellent water quality functions and moderate habitat functions.	Forested, scrub-shrub, emergent	Depressional	Groundwater	Residential development	Restoration	Forested and lawn grass for most of its circumference. Sammamish buffer is 100 feet.	Category II (Moderate)
1559 (East Lake Sammamish 59)	6.3	Provides moderate water quality, hydrologic, and habitat functions.	Forested, scrub-shrub	Depressional	Seeps. Seasonally flooded/saturated	Residential development	Minimal	Forested for 1/2 of its circumference. Sammamish buffer is 75 feet.	Category II (Low)
1832 (Evans Creek #32, Llama Lake)		Provides moderate water quality and hydrologic functions and low habitat functions	Emergent, open water	Depressional	Groundwater, seasonally flooded/saturated	Residential development	Restoration	Forested and lawn grass. Sammamish buffer is 50 feet.	Category III (Low)
13		May be a stormwater feature created from construction of condos. South of Inglewood Hill Road	Emergent	Depressional					
14		At base of slope near Presbyterian Church north of Inglewood Hill Road	Emergent	Depressional	Seep, runoff	Residential development		Forested for 1/2 of its circumference	(Low)
18	17.2	Headwater tributary to George Davis Creek	Forested, scrub-shrub, emergent	Riverine	Surface water	Residential development	Restore artificial ponds. Replant lawn with native vegetation	Buffer for 1/2 of its circumference	(High)

[a] If the wetland was previously named, this name was used. If the wetland was not named wetlands were numbered beginning with 1 and ending with 18. Previous wetland names (e.g. wetland 17) were not used to avoid two wetlands having the same name.

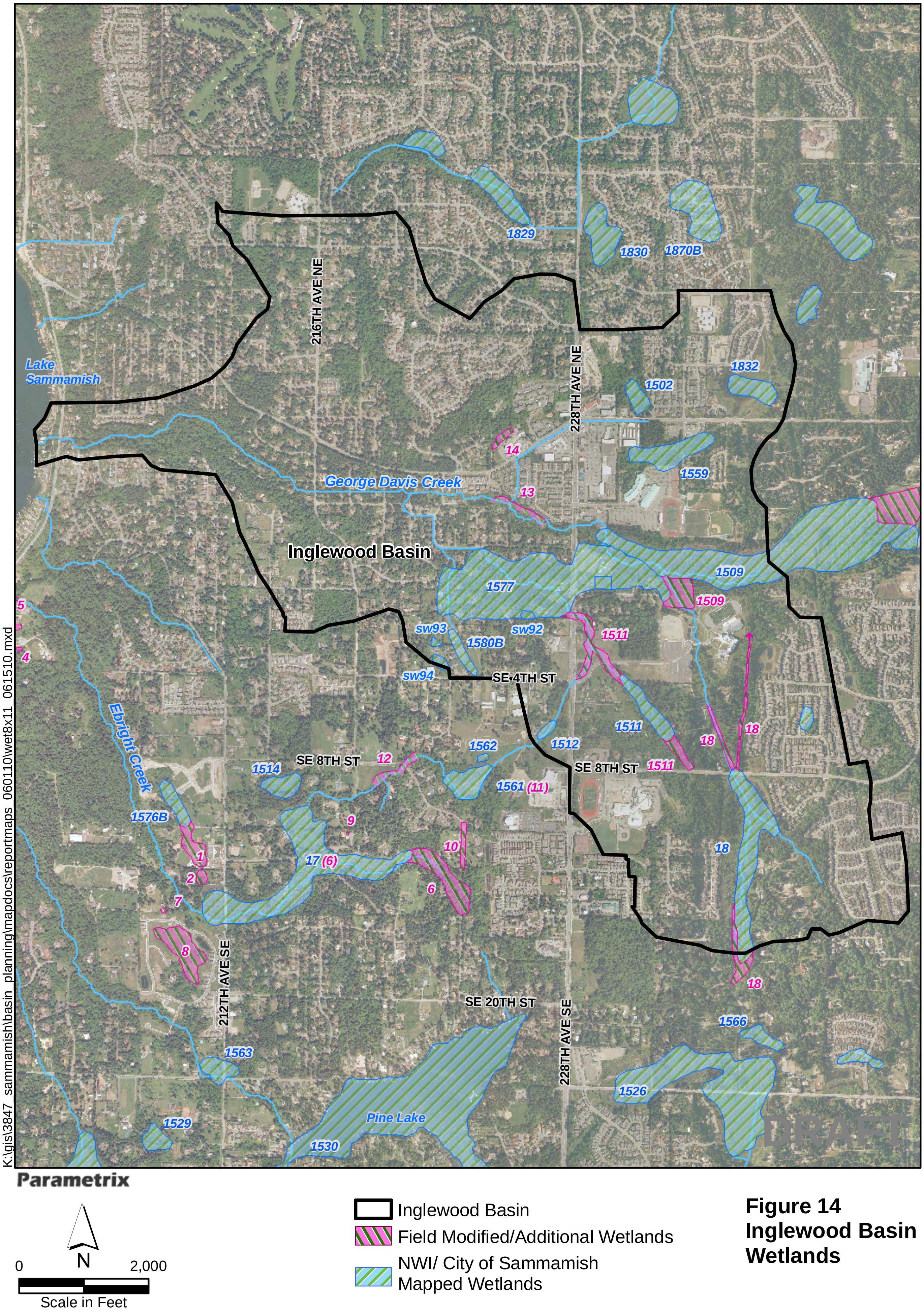


Figure 14
Inglewood Basin Wetlands

3.6 STREAM AND HILLSLOPE GEOMORPHOLOGY

In the early 1990s King County conducted previous field studies of George Davis Creek and the Inglewood Basin. Results of these efforts are documented in the King County Basin and Nonpoint Action Plan for the East Lake Sammamish Basin (King County 1995) as well as the East Lake Sammamish Basin Conditions Report—Preliminary Analysis (King County 1990). The 2008 field efforts of Parametrix were compared to field notes collected by King County in the early 1990s. The King County evaluation occurred after a very large storm event in January 1990 that flooded East Lake Sammamish Parkway and caused extensive damage to the George Davis Creek channel downstream of 216th Avenue NE. The channel is this area is located in a forested ravine with very steep side-slopes. Evidence of several landslides were observed by King County, and again by Parametrix, particularly on the south side of the ravine. In the intervening years since the King County study, a large restoration effort has occurred, with large woody debris/root wad structures installed in the stream channel at approximate 50- to 100-foot intervals. It appears that these structures serve to minimize downstream sediment movement from landslides and high flows.

One 12-inch diameter stormwater discharge pipe was observed on the north hillside of George Davis Creek. This pipe has been tightlined down the hill and is equipped with an energy dissipater. Other smaller stormwater pipes were observed from individual residences on the south hillside. These pipes have all been tightlined to the stream channel to prevent hillslope erosion.

George Davis Creek flows intermittently and is fed by both surface flow and groundwater seepage. The channel appears to be in fairly stable condition, with the exception of an area just upstream of East Lake Sammamish Parkway adjacent to several residences. The creek is incised in this area ranging from 2.5 to 6 feet (Photograph 2).

Photograph 2. Incised stream channel adjacent to residence

Upstream of 216th Avenue NE, George Davis Creek and its tributaries consist of stream channels that are alternately straightened channels located adjacent to roads or residences and undefined channels associated with wetlands. The stream channel segments upstream of 216th Avenue NE are dry most of the year (Photograph 3).

Photograph 3. Dry streambed upstream of 216th Avenue NE

Appendix C summarizes conditions observed in 1990 and 2008, documented downstream to upstream. Appendix D provides a sequence of photographs of George Davis Creek, starting at the mouth and proceeding upstream. The photographs are representative of the general stream conditions in the various portions of the stream. Overall, the riparian buffers appear to be functioning properly and the stream channel is generally stable.

3.7 FISH HABITAT AND USE

George Davis Creek historically served as habitat for coho and sockeye salmon according to the Washington Department of Fisheries Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975). Aquatic habitat conditions were assessed by fish biologists during field reconnaissance surveys conducted on December 3 and 4, 2008. In general habitat conditions between East Lake Sammamish Parkway and NE 6th Street could be considered good. This area has a great riparian corridor, good supply of large woody debris (partially due to restoration efforts), and quality stream gravel. However, there are multiple fish passage barriers that prevent anadromous fish from using this reach and supply of water is intermittent. The most downstream fish barrier is near the mouth of Lake Sammamish, where George Davis Creek is conveyed through a house in a concrete box structure. This downstream end of this barrier has been removed, with reconstruction of the house, however, the upstream box that conveys flow through another residential lot was not planned to be replaced. The East Lake Sammamish Parkway crossing is also a fish passage barrier, consisting of several stormwater manholes and culverts. Just upstream of East Lake Sammamish Parkway is a 3.5-foot tall concrete water diversion dam (no longer operational) that conveys water through holes in the wall (Photograph 4).

Photograph 4. George Davis Creek flow through old water supply diversion dam upstream of East Lake Sammamish Parkway

3.8 WATER QUALITY

No recent water quality samples have been collected for George Davis Creek. In the 2005 Inglewood Basin Plan (Entranco 2005), it was reported that George Davis Creek is on Ecology's 303(d) Category 5 list for impaired waters due to elevated levels of fecal coliform bacteria. George Davis Creek is still on the 2008 303(d) list for fecal coliform bacteria (Ecology 2008).

4. RECOMMENDED STRATEGIES

Specific features that define the Inglewood Basin and are important considerations in the development of projects and strategies are as follows:

Geology—The underlying geology in the Inglewood Basin consists of compacted till and highly infiltrative recessional glacial outwash. The outwash serves a very important function in this basin, serving as a gigantic subsurface reservoir that recharges deeper groundwater aquifers and supplies flow to George Davis Creek and associated wetlands. It is important to minimize development of impervious surfaces on these highly infiltrative areas to protect the groundwater recharge capacity.

Wetlands—There are very high quality, large wetlands in the Inglewood Basin that provide hydrologic functions of storing water and attenuating flood flows as well as providing diverse habitat for birds and other wildlife species. It is important to protect these areas for their critical functions.

Fish Passage Barriers—There are at least three fish passage barriers on George Davis Creek within the first 1/2 mile of Lake Sammamish. Despite relatively good fish habitat, these barriers represent a costly and unlikely restoration of anadromous fish populations to the lower reaches of George Davis Creek. For this reason, the removal of these barriers is not recommended as part of this plan.

The projects and strategies recommended below are designed to preserve ecological function in areas that are currently functioning well, solve existing problems, and prevent future degradation as the Inglewood Basin is further developed. Specific projects identified are presented in more detail in Appendix E.

4.1 PRESERVATION AND ENHANCEMENT OF ECOLOGICAL FUNCTION

The natural areas (George Davis Creek and associated wetlands) in the Inglewood Basin are now largely protected through existing ordinances, however, past actions and developments have resulted in fish passage barriers and loss or degradation of wetlands. Still, the George Davis Creek riparian corridor and many of the associated wetlands are in very good condition. Through the City’s Critical Areas Ordinance, areas adjacent to stream corridors and wetlands are protected with buffers up to 215 feet. It is important to enforce this ordinance and prevent encroachment of development into stream and wetland buffers to prevent future degradation.

The 2005 Inglewood Basin Plan (Entranco 2005) recommended making the mouth of George Davis Creek fish passable. Given the extent of barriers in George Davis Creek and the availability of year-round flow, it is probably not worth the expense of providing fish passage in this stream when there are other projects that would result in greater benefits to fish and the natural resources.

Table 5 lists some strategies to preserve and enhance existing ecological function in the Inglewood Basin. Full descriptions and planning level cost estimates are provided in Appendix E.

Table 5. Strategies to Preserve or Enhance Ecological Function in the Inglewood Basin

Strategy	Project Identification	Type of Strategy: Planning	Education	Capital	Description	Potential Partners
Enhance Wetland 1509	Enh-1			X	Restore/enhance pasture area in Wetland 17	Private property owners, developers in need of potential mitigation, conservancy groups
Conduct wetland tours	Ed-1		X		Sponsor wetland tours to foster appreciation and stewardship of Sammamish wetlands	Audubon Society, non-profit environmental groups

4.1.1 Capital Project

4.1.1.1 Implement Wetland Enhancement

Washington State and federal regulatory agencies require that mitigation efforts follow the prescribed sequence below:

- Avoiding the impacts altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing, enhancing, or providing substitute resources or environments.
- Monitoring the impact and taking appropriate corrective measures.

In light of these requirements preservation of existing wetlands is recommended, especially the Wetland Complex of 1509 and 1577. This can be done through enforcement of existing critical areas regulations (SMC 21A.50), outright purchase of properties, or establishment of conservation easements. Outright purchase of these properties is likely cost prohibitive; however, the city could consider using funds from their critical areas mitigation fee program (SMC 21A.50.360) to secure properties consistent with a watershed-based mitigation strategy. Alternatively, these projects could act as stand-alone watershed management projects. Mitigation opportunities are limited in the Inglewood Sub-basin primarily because so much of it has recently been developed with inadequate protection of the wetlands and their buffers. Entire subdivisions and schools would need to be removed to make significant improvements to the watershed, which is impractical. In addition, due to the recent development a number of the wetlands and their buffers have been impacted and mitigation has occurred. The areas that have already been subject to mitigation cannot be used for mitigation again. The City should also focus their efforts on ensuring these mitigation areas are successful, and effective enforcement of existing regulations including monitoring, contingency measures, and collection of bonds (SMC 21A.50.140 to 21A.50.190).

As mitigation opportunities are limited, only one potential mitigation projects are suggested. The proposed project is based on limited field observations from publicly accessible sites and photo interpretation. Other mitigation opportunities likely exist. The proposed mitigation option would require a wetland delineation and further evaluation of the wetland for mitigation potential. Mitigation would require either purchase of the property, establishment of a conservation easement and cooperation of the landowner.

4.1.1.2 Enhance Wetland 1509 (Enh-1)

The property at 425 244th Avenue NE (parcel 3425069047) has been cleared for pasture and lawn and there is a house and at least one out building on the property. Some of this area; approximately 100,000 square feet could be re-established and/or rehabilitated to wetland and wetland buffer habitat. The area would require excavation of fill materials (where present) and grading as well as the removal of man made structures and non-native species. The wetland area would be planted with scrub shrub species (salmonberry, twin berry, and willows). The buffer area would be planted with species similar to those in the adjacent forested buffer (Douglas fir and western redcedar). Permanent signs would be installed to identify the wetland as a protected area. There are likely other similar re-establishment and/or enhancement opportunities along Wetland 1509 where pastures and lawns abut Wetland 1509. The area for this project option is approximate. A wetland delineation and further investigation would be required.

4.1.2 Educational Strategy

4.1.2.1 Conduct Wetland Tours (Ed-1)

The Inglewood Basin has some high quality wetlands that provide important ecological functions, including attenuation of stormwater runoff and habitat for terrestrial and aquatic species. One of the best ways to educate citizens about stewardship of their natural environment is to show them. Wetland tours that feature Wetlands 1509, 1511 and 1577 in the Inglewood Basin, as well as other unique wetland environments on the Sammamish Plateau would be one way to promote environmental stewardship, and increase understanding as to the importance of wetlands.

4.2 REDUCE EFFECTS OF ONGOING STORMWATER DISCHARGES FROM EXISTING DEVELOPMENT

Three stormwater drainage problems were identified during this basin planning effort. Aside from these issues, there doesn’t appear to be any significant flooding, stream channel erosion, or wetland elevation changes associated with stormwater discharges in the Inglewood Basin. This may be in part due to the presence of highly infiltrative recessional outwash.

Table 6 lists projects to reduce the effects of ongoing stormwater discharges in Inglewood Basin. Full descriptions and planning level cost estimates are provided in Appendix E.

Table 6. Projects to Reduce Ongoing Stormwater Impacts

Strategy	Project Identification	Type of Strategy			Description	Potential Partners
		Planning	Education	Capital		
NE 217th Street Road Drainage Modification	CIP-1			X	Modify road drainage to prevent flooding at adjacent residence.	None.
228th Avenue NE Drainage Modification	CIP-2A or-2B			X	Modify discharge of stormwater runoff from road outfall to prevent downstream erosion and saturated conditions that appear to be causing trees to die.	None.
NE 2nd Avenue Culvert Replacement	CIP-3			X	Replace damaged culverts at driveway crossing to prevent possible roadway flooding.	Property owner.

4.2.1 Capital Strategies

4.2.1.1 NE 217th Street Road Drainage Modification (CIP-1)

This project involves modifying the drainage features on NE 217th Street, including installation of a curb to the road shoulder to direct water away from the residence that experiences flooding. Catch basins and pipes would be installed to collect and convey water from the east side of the road to the existing detention facility located downstream.

4.2.1.2 228th Avenue NE Drainage Modification (CIP-2A or -2B)

This project involves modifying an existing drainage outfall located on the west side of 228th Avenue NE. Currently the outfall discharges to an open channel on a steep slope and conveys water to the base of the hill where it pools and has resulted in saturated conditions that have killed several trees. There are two alternatives that could solve the existing erosion and saturation problem. The first alternative (CIP-2A) consists of tightlining the stormwater runoff from the outfall to and existing pond. The second alternative (CIP-2B) consists of adding stormwater conveyance in the right-of-way on 228th Avenue NE from the outfall to George Davis Creek at SE 4th Street.

4.2.1.3 NE 2nd Avenue Culvert Replacement (CIP-3)

This project involves the replacement of two 24-inch culverts that convey George Davis Creek under a driveway on NE 2nd Avenue. The culverts are damaged and could result in flooding on NE 2nd. The culverts are sized appropriately and could be replaced with one culvert of equivalent capacity.

4.3 PLAN FOR FUTURE IMPACTS AND MINIMIZE EFFECTS

The Inglewood Basin will likely undergo changes in the next several decades, including development of the proposed Town Center and conversion of forested parcels to denser development in accordance with current zoning. Most of the parcels that can be expected to be developed over the next several decades are located in critical areas or within the Town Center. In these areas there are regulations and standards in place to require responsible management of stormwater to protect the resources. Stormwater management techniques and strategies are constantly evolving; currently, the regional emphasis is on low impact development to minimize the effects of stormwater runoff. This is the recommended approach for the Town Center (Parametrix 2009), and is one of the only ways to mitigate stormwater volume resulting from land conversion.

The Town Center Comprehensive Stormwater Plan recommended using the LID techniques listed in Table 7 to mitigate stormwater runoff.

Table 7. Summary of Stormwater Treatment Requirements and Preferred Choices

Type of Impervious Surface	Treatment Required		First Choice	Second Choice	Third Choice
	Water Quality	Flow Control			
Rooftops		√	Rainwater Harvesting and Reuse	Green Roofs	Bioretention
Roads and Parking Lots	√	√	Minimize Surfaces	Bioretention	Pervious Pavement
Sidewalks and Patios		√	Pervious Pavement	Full Dispersion	Bioretention

The City of Sammamish has adopted an LID ordinance in which LID is provided incentives for new development. There has been little opportunity to test the effectiveness of this ordinance for encouraging use of LID because the economic slowdown of 2009 to 2010 has resulted in little to no development in the city. Whereas the LID ordinance is voluntary, LID will likely be mandatory (to the extent practical) in the Town Center (Parametrix 2010).

In addition to the use of technical methods to accomplish stormwater management goals, such as LID, there are other implementation mechanisms that could be explored in the future. Some of these implementation strategies are described in the Draft Non-Traditional Stormwater Approaches Memorandum (Parametrix 2009b).

Maintenance of the recessional outwash infiltration area is important because this helps ensure a stable flow regime in George Davis Creek. The critical aquifer recharge areas designated in the CAO are coincident with these outwash areas and the CAO requires that 75% of stormwater volume generated from development in these areas is infiltrated. This requirement should be enforced through the development review process.

Several programmatic strategies were recommended in the 2005 Inglewood Basin Plan (Entranco 2005), including the following:

- Maintain Current Detention Standards
- Encourage Widespread Use of Low Impact Development Techniques
- Maintain Hydraulic Connectivity to Infiltration Areas
- Map Infiltration Areas
- Identify Potentially Flood Prone Properties
- Improve Wetland Maps

- Preserve Infiltration Areas as a Natural Resource
- Public Education and Outreach Programs
- Reduce Phosphorus to Lake Sammamish
- Remove Solids for Protection of Infiltration Areas
- Limit Livestock Access to Creeks
- Install Flow Gages in the Upper Basin
- Investigate Sources of Fecal Coliform Bacteria

An assessment of these strategies and current recommendations is shown in Table 8. No additional strategies or projects are recommended at this time to address future impacts.

Table 8. Previously Recommended Strategies to Plan for and Reduce Effects of Future Stormwater Runoff

Strategy	Purpose	Current Relevance	Concur with Recommendation?
Maintain Current Detention Standards	Reduce flooding potential throughout the basin, limit impacts to stream channels.	Although there are few flooding problems and little evidence of stream channel erosion due to high flows, current flow control standards should be maintained so that problems do not arise if the infiltration capacity of the outwash soils is exceeded.	Yes
Encourage Widespread Use of Low Impact Development (LID)Techniques	Use on-site infiltration techniques to reduce sizes of traditional facilities and recharge aquifers.	The City is encouraging the widespread use of low impact development techniques through its LID ordinance, and demonstration projects such as the use of pervious pavement at City Hall.	Yes
Maintain hydraulic Connectivity to Infiltration Areas	Provide opportunities for infiltration by maximizing use of open conveyance systems that are unlined.	Much of the stormwater infrastructure in the Inglewood basin consists of open conveyance systems. Continue using open systems where possible.	Yes
Map Infiltration Areas	Understanding the best infiltration areas will facilitate better protection and/or use of these areas for stormwater management.	Areas of existing infiltration areas are based on geologic maps prepared by the USGS. Geotechnical reports for projects in the area match geologic units mapped by the USGS. This level of detail should be sufficient for planning level stormwater management. Site-specific investigations should be done at the time of project development.	No
Identify Potentially Flood Prone Properties	Know in advance what properties are likely to flood due to exceedance of infiltration capacity in outwash.	Unless there have been specific problems associated with infiltration capacities being exceeded, this would be difficult to evaluate without a detailed subsurface evaluation.	No
Reduce Phosphorus to Lake Sammamish	Improve water quality in Lake Sammamish through enhanced stormwater treatment that removes phosphorus	Phosphorus removal should be more focused on the lower portion of the basin, as much of the stormwater runoff in the upper part of the basin infiltrates and effectively removes phosphorus.	Yes

Strategy	Purpose	Current Relevance	Concur with Recommendation?
Remove Solids for Protection of Infiltration Areas	Removal of large sediment from runoff will help preserve beneficial function of outwash soils for infiltration.	Construction requirements for temporary sediment and erosion control and stormwater facility pre-treatment requirements target removal of sediment. Regular inspection of construction sites and stormwater facilities should be done to identify and correct problems.	No, already is done.
Limit Livestock Access to Creeks	Limit livestock access to stream channels to prevent sedimentation and fecal coliform bacteria pollution.	Very few livestock were observed in this basin. Confirm is this is a current problem.	No, unless this is still a problem
Install Flow Gages in the Upper Basin	Recording flows in the outwash area will provide a better understanding of infiltration capacity.	Gages have not been installed, but would add valuable information.	Yes
Investigate Sources of Fecal Coliform Bacteria	Identification of fecal coliform sources will help target reductions.	It is not known whether fecal coliform bacteria is still a problem in George Davis Creek as the water quality data is old. Source tracing is costly and unreliable.	No
Improve Wetland Maps	More accurate wetland maps are important for enforcement of CAO requirements and protection of these resources.	The wetland maps should be updated, as delineations are only valid for 5 years and the existing wetland information appears to be out of date.	Yes
Preserve Infiltration Areas as a Natural Resource	Protection of the infiltration capacity of the outwash in the basin will preserve this natural resource and help maintain moderate flows to downstream reaches.	Most of the undeveloped infiltration areas are also designated as critical areas that have additional requirements for stormwater management. The City should evaluate whether the areas identified in the 2005 Inglewood Basin Plan are adequately protected with ordinances.	Yes, unless adequate protection already exists
Public Outreach and Education Programs	Work with land owners to achieve a positive outcome beneficial to George Davis Creek.	The City is required to do public outreach and education as part of its NPDES Phase II permit. Inglewood Basin could be targeted for certain types of education.	Yes

5. PROJECT PRIORITIZATION

The projects recommended above represent solutions to existing problems in the Inglewood basin. Many of the recommended projects would be eligible for grant funding, which will be discussed below. Parametrix prioritized the projects using several criteria, including (1) likelihood of success at achieving the desired outcome, (2) degree to which project meets multiple objectives, (3) degree to which project alleviates threats to wildlife and habitat or property, and (4) cost.

5.1 CRITERIA

Table 9 lists the criteria and rank scores associated with a high, medium or low ranking for each criteria.

Table 9. Criteria and scoring for project prioritization

	Rank scores		
Criteria	**High (5 pts)**	**Medium (3 pts)**	**Low (1 pt)**
Likelihood of Success	Proven in other cases	Mixed results in other cases	Unproven
Number of Issues Addressed	More than three	Two to three	One
Protects habitat	Protects both habitat and property	Protects habitat OR property	Protects neither
Cost Category (first 5 years)	< 20K	(20K – 50k)	(> 50k)

The combined scores of individual criteria were ranked according to the following scores:

Low priority (6 – 8 total points)

Medium priority (10 – 12 total points)

High priority (over 12 total points)

5.2 MATRIX OF PROJECTS

Table 10. Matrix of Recommended Projects

		Type of Strategy						Project Criteria				
Strategy	Project Identification	Planning	Education	Capital	Description	Potential Partners	Cost	Likelihood if Success	Number of Issues Addressed	Protects Habitat	Cost	Priority
Rehabilitate and Enhance Wetland 1509	Enh-1			X	Restore/enhance pasture area in Wetland 1509	Private property owners, developers in need of potential mitigation, conservancy groups	$164,000	H	H	H	L	High
Conduct Wetland Tours	Ed-1		X		Sponsor wetland tours to foster appreciation and stewardship of Sammamish Wetlands	Audubon Society, non-profit environmental groups	$6,000	L	L	L	H	Low
NE 217th Street Road Drainage Modification	CIP-1			X	Improve road drainage to reduce flooding to neighboring residence.	None	$59,000	H	L	L	L	Low
228th Avenue NE Stormwater Discharge Modification	CIP-2			X	Modify stormwater outfall discharge from 228th Avenue NE to reduce erosion and saturated conditions.	None	$55,000 - $78,000	H	M	M	L	Medium
NE 2nd Street Culvert Replacement	CIP-3			X	Replace culverts at NE 2nd Street driveway.	None	$40,000	H	L	L	H	Medium

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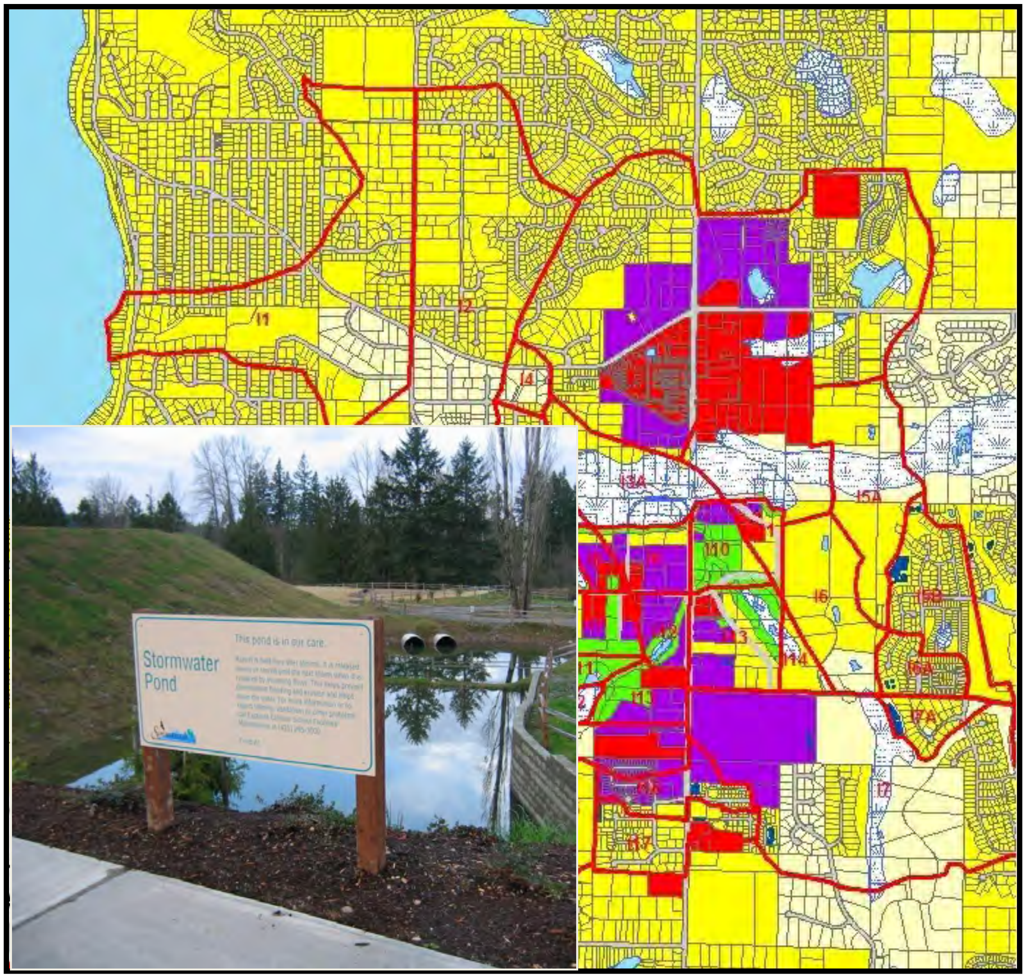
APPENDIX A

Hydrologic Modeling Report

Hydrologic Analysis of the Inglewood Basin, Thompson Basin and Sammamish Town Center Using the HSPF Model



Prepared for

The City of Sammamish

by

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December 8, 2009

Hydrologic and Hydraulic Analysis of Inglewood Basin, Thompson Basin, and Sammamish Town Center Using the HSPF Model

Prepared for

The City of Sammamish

by

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The engineering analyses and technical material presented in this report were prepared under the supervision and direction of the undersigned professional engineer.

Bruce Barker, P.E.

EXECUTIVE SUMMARY

This report documents the development of hydrologic models used in the analysis of the Inglewood Basin, Thompson Basin, and Sammamish Town Center. The models were developed to quantify the runoff conditions in the two principal streams; George Davis and Ebright creeks under historic, current, and future land use. In addition, the models were used to analyze the effectiveness of stormwater controls at mitigating the increased runoff associated with future development in the basins.

Two hydrologic models were used in the analysis; the Hydrological Simulation Program-Fortran (HSPF) model and MGSFlood. HSPF has been used extensively in the Puget Sound region over the past 20 years for stormwater analysis. The HSPF model input was originally developed by King County as part of East Lake Sammamish Basin Plan in the mid 1980's and subsequently updated by the City of Sammamish for the Inglewood Basin Plan in 2004. The model input was updated and refined for the current study and recalibrated to streamflow data collected over a 20 month period from October 2001 through May 2003. HSPF model input and calibrated parameters were used in MGSFlood to analyze mitigation alternatives that included stormwater detention and Low Impact Development (LID).

The Inglewood Basin encompasses approximately 1640 acres (2.6 square miles) of suburban land in the City of Sammamish tributary to George Davis Creek. The geology in the central portion of the watershed is composed of highly infiltrative glacial outwash deposits. The outwash infiltrates the majority of surface flow produced in the upper parts of the watershed and results in little or no flow in the stream immediately upstream of the ravine. The stream intersects the groundwater table in the ravine and receives the majority of flow via groundwater discharge in this area. The groundwater discharge also produces year around base flow in the lower reaches of the stream. The outwash deposit infiltrates and stores runoff from the upper watershed and is equivalent to approximately 7,000 acre-feet of stormwater detention storage. Flows in the lower stream reaches are relatively low (attenuated) during floods because of the storage that occurs in the outwash deposit.

The Thompson Basin is located adjacent to the Inglewood basin and drains 800 acres (1.3 square miles) of suburban land via Ebright Creek. The Thompson Basin does not have the same infiltrative outwash deposit as the Inglewood basin, but does have a large wetland (Wetland 17) situated at the top of the ravine. This 30 acre wetland provides substantial flood attenuation and buffering of flows entering from the uplands before discharging to the ravine.

Historic (forested), existing, and future build-out conditions were simulated with the hydrologic models, and flood peak and flow duration statistics were computed. Little or no increases in runoff rates relative to existing conditions were predicted under the mitigated future land use scenario for the Inglewood Basin. In the Thompson Basin, future peak flow rates were predicted to decrease relative to existing conditions. These results show that stormwater mitigation designed according to the City's stormwater detention standard, which seeks to control runoff rates and durations to forested conditions, is effective at mitigating increased runoff associated with development. Because of this, the rates of erosion and flooding should not increase in the future and in most areas of the Thompson Basin, may actually decrease provided that the facilities are properly designed, constructed, and maintained.

The report includes the following recommendations to maintain a stable flow regime to ensure the health of the stream system in the future:

- Maintenance of Outwash Infiltration Areas – The glacial outwash deposit in the central part of the Inglewood Basin is currently infiltrating the majority of surface runoff from the upper watershed. Maintaining the infiltration function of this area is critical to ensuring a stable flow regime and the health of the stream. In addition, infiltration of urban runoff should be encouraged wherever feasible in the Thompson watershed.

- On-Site Detention Standard – The City's proposed detention standard, which is consistent with the 2005 Ecology Stormwater Management Manual, is effective at mitigating the increased potential for flooding and erosion associated with development. Stormwater detention facilities designed according to this standard are large and often expensive to construct. Low Impact Development (LID) methods provide a means to reduce the rate and volume of runoff associated with development, and increases the amount of potential groundwater recharge. LID methods can reduce the size of detention facilities, or replace them altogether. LID methods should be encouraged to the greatest extent practical for new construction in the Inglewood and Thompson Basins.

- Streamflow Monitoring – Streamflow gages have been operated and maintained by a private contractor in the past at the mouth of George Davis and Ebright creeks. These gages should be reestablished and the data collected from them quality checked and validated on an on-going basis.

TABLE OF CONTENTS

Hydrologic Analysis of the
Inglewood Basin, Thompson Basin, and Sammamish Town Center

INTRODUCTION

This report presents findings of a hydrologic analysis of the Inglewood and Thompson Basins in the City of Sammamish. The analysis was performed using the Hydrological Simulation Program Fortran[1] (HSPF) and MGSFlood[2] hydrologic models. The purpose of the analysis was to determine streamflow magnitude-frequency and flow duration statistics at locations of interest in the watersheds under existing and future land use, and determine the effectiveness of mitigation alternatives.

The proposed Sammamish Town Center project, which consists of approximately 208 acres of residential and commercial development, straddles the Thompson/Inglewood basin divide. MGSFlood model and input was developed for historic, existing and future land use. MGSFlood includes routines for quickly analyzing mitigation alternatives including detention and Low Impact Development (LID) techniques.

HSPF MODEL ANALYSIS APPROACH

SUBBASIN DELINEATION INGLEWOOD BASIN/GEORGE DAVIS CREEK

The Inglewood Basin encompasses approximately 1640 acres (2.6 square miles) of suburban land in the City of Sammamish. The principal stream in the Inglewood Basin is named George Davis Creek. The creek originates at a wetland area on the Sammamish plateau and drops approximately 400 feet in three miles to Lake Sammamish (Figure 1).

HSPF model input for the watershed was developed by the USGS[3] and utilized by King County as part of the 1991 East Lake Sammamish Basin Plan[4]. The model was updated in 2004 for the Inglewood Basin Plan Update[5]. The model input was modified in the current analysis to reflect changes in land use that have occurred since 2004, and additional subbasins were added for the analysis of the Sammamish Town Center.

SUBBASIN DELINEATION THOMPSON BASIN/EBRIGHT CREEK

The Thompson Basin is located south of Inglewood and receives runoff from approximately 800 acres (1.25 square miles) of suburban land. The principal stream is Ebright Creek, which originates on the Sammamish plateau and discharges to Lake Sammamish (Figure 1).

HSPF model input for the watershed was developed by the USGS[3] and utilized by King County as part of the 1991 East Lake Sammamish Basin Plan[4]. The model was updated as part of the current analysis to reflect changes in land use, include additional subbasins, and update routing hydraulics.

Subbasin Delineation Town Center

The proposed Sammamish Town Center is a commercial and residential development that encompasses approximately 208 acres in the headwaters of both the Thompson and Inglewood basins (Figure 1). Decisions on flow control standards and mitigation alternatives will affect the streams and wetlands in both the Thompson and Inglewood Basins. The subbasin delineation for the Town Center was based on local topography and the 2008 Town Center Plan[5], which defined land use throughout the Town Center Complex. Subbasins delineated for the Town Center are shaded in Figure 1.

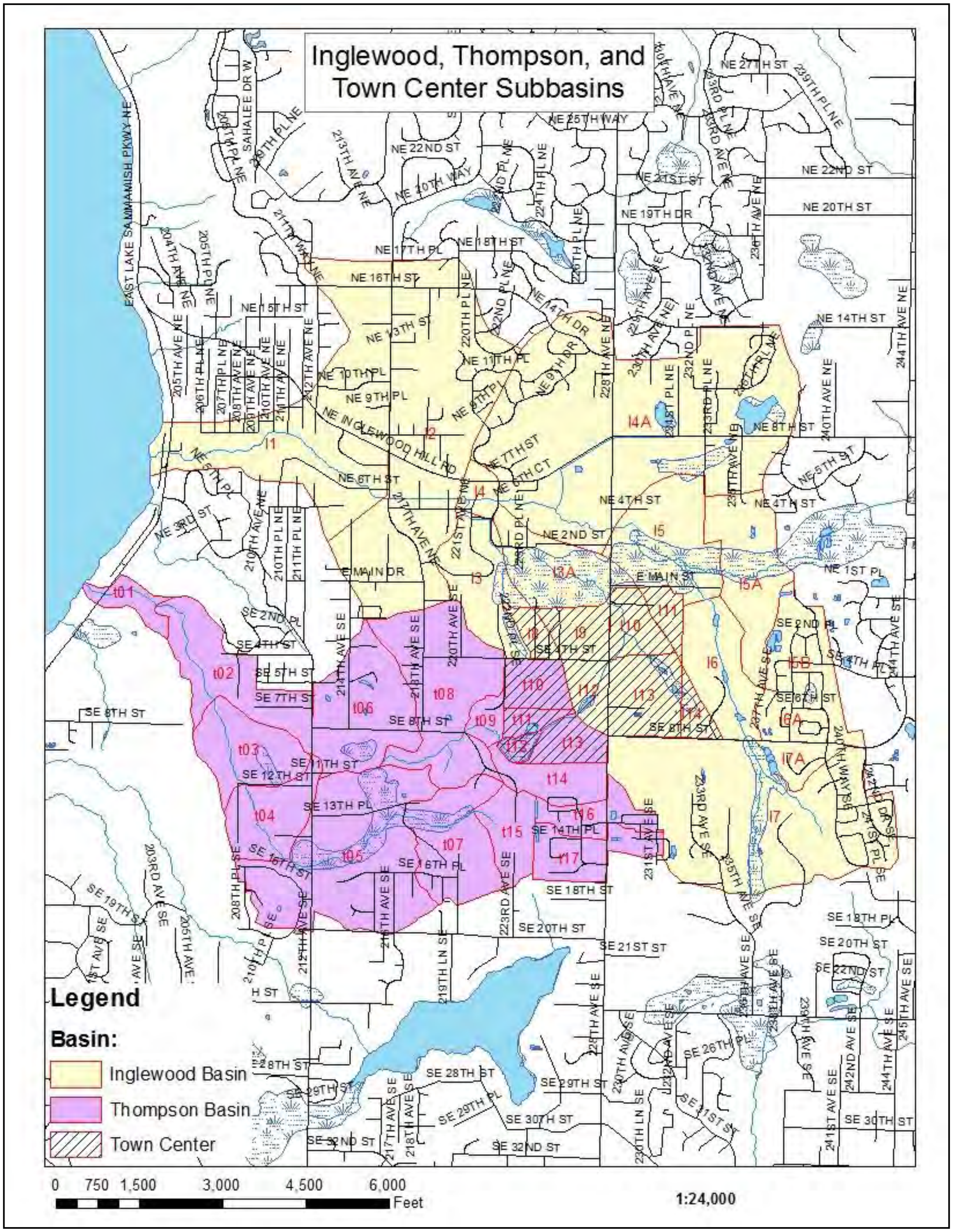


Figure 1 – Inglewood Basin, Thompson Basin and Town Center Subbasins

LAND USE SCENARIOS ANALYZED

Three land use scenarios were analyzed; historic conditions, existing land use, and future build-out. Each scenario is summarized in the sections below.

Historic Land Use

Historic land use was analyzed to provide an assessment of conditions in the watershed prior to any development or land use alterations by humans. The scenario was developed by replacing all land covers except for wetlands in the existing land use scenario with forest. All constructed stormwater control facilities are also assumed to be removed. This scenario is useful for estimating what the hydrologic conditions were that led to the formation of the streams.

Existing Land Use

Existing land use was developed based on aerial photos taken in 2006. Land use was defined based on the categories shown in Table 1. The existing land use coverage is shown in Figure 2. Significant existing stormwater detention facilities were included in this scenario. In addition, this scenario was used in hydrologic model calibration to ensure that simulated runoff matched recorded data.

Future Land Use

The future land use scenario was developed based on current zoning and the Town Center Plan[5]. Each land use zone was assigned to one of the hydrologic land uses defined in Table 1 resulting in the Future Land Use Coverage shown in Figure 3. This scenario represents future build-out conditions in the watershed and is the most severe hydrologic condition. Stormwater flow control measures were included for areas that increased in development density relative to existing conditions.

Land Cover Categories

Four land cover categories were considered in analyzing the watershed hydrology: forest, grass, wetland, and impervious. The percentage of each cover allocated to the mapped land uses are shown in Table 1. The effective impervious surface areas were determined based on relationships with mapped impervious surface developed by Sutherland[6] and Dinicola[7].

Table 1 – Land use and Percentage of HSPF Cover Categories

Land Use Code	Land Use	Effective Impervious	Grass	Forest	Wetland
C	Commercial/Industrial	85%	15%	0%	0%
MF	Multi-Family	48%	52%	0%	0%
H	High Density Residential	23%	75%	0%	0%
L	Low Density Residential	10%	90%	0%	0%
RF	Rural Residential Forest	4%	0%	96%	0%
RG	Rural Residential Grass	4%	0%	0%	0%
G	Grass	0%	100%	0%	0%
F	Forest	0%	0%	100%	0%
W	Wetlands/Open Water	0%	0%	0%	100%

The area within each subbasin was classified into areas of common land cover and geologic/soil type, called *PERLNDS*. The HSPF and MGSFlood models compute the hydrologic response of each PERLND within a subbasin on a per-unit-area basis and proportions the amount of surface runoff, interflow and groundwater entering the stream within each subbasin consistent with the PERLND area total for the subbasin.

The area of each category under forested, existing, and future build-out conditions for each basin is summarized in Appendix A.

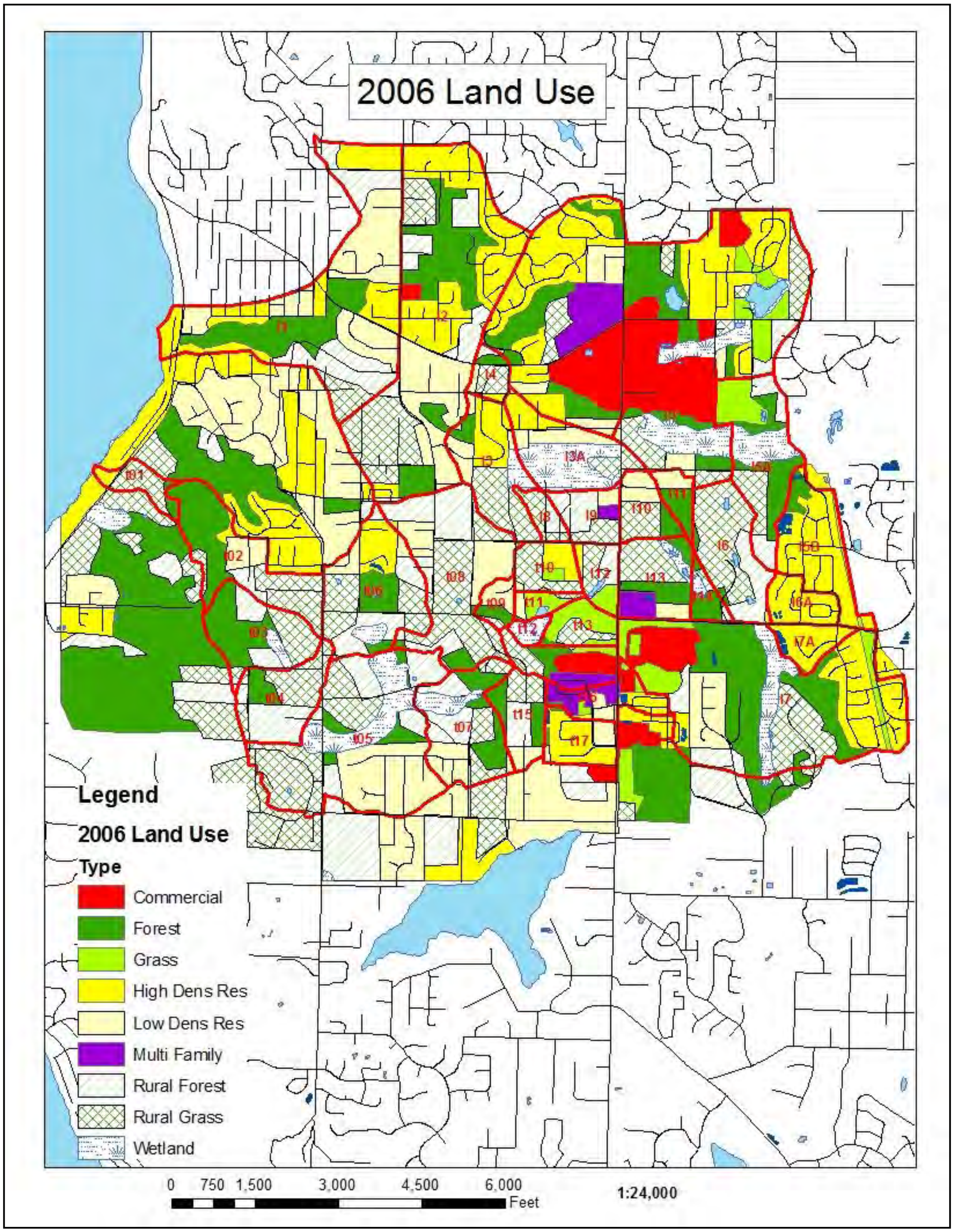


Figure 2 – Inglewood and Thompson Basins, Existing Land Use (2006)

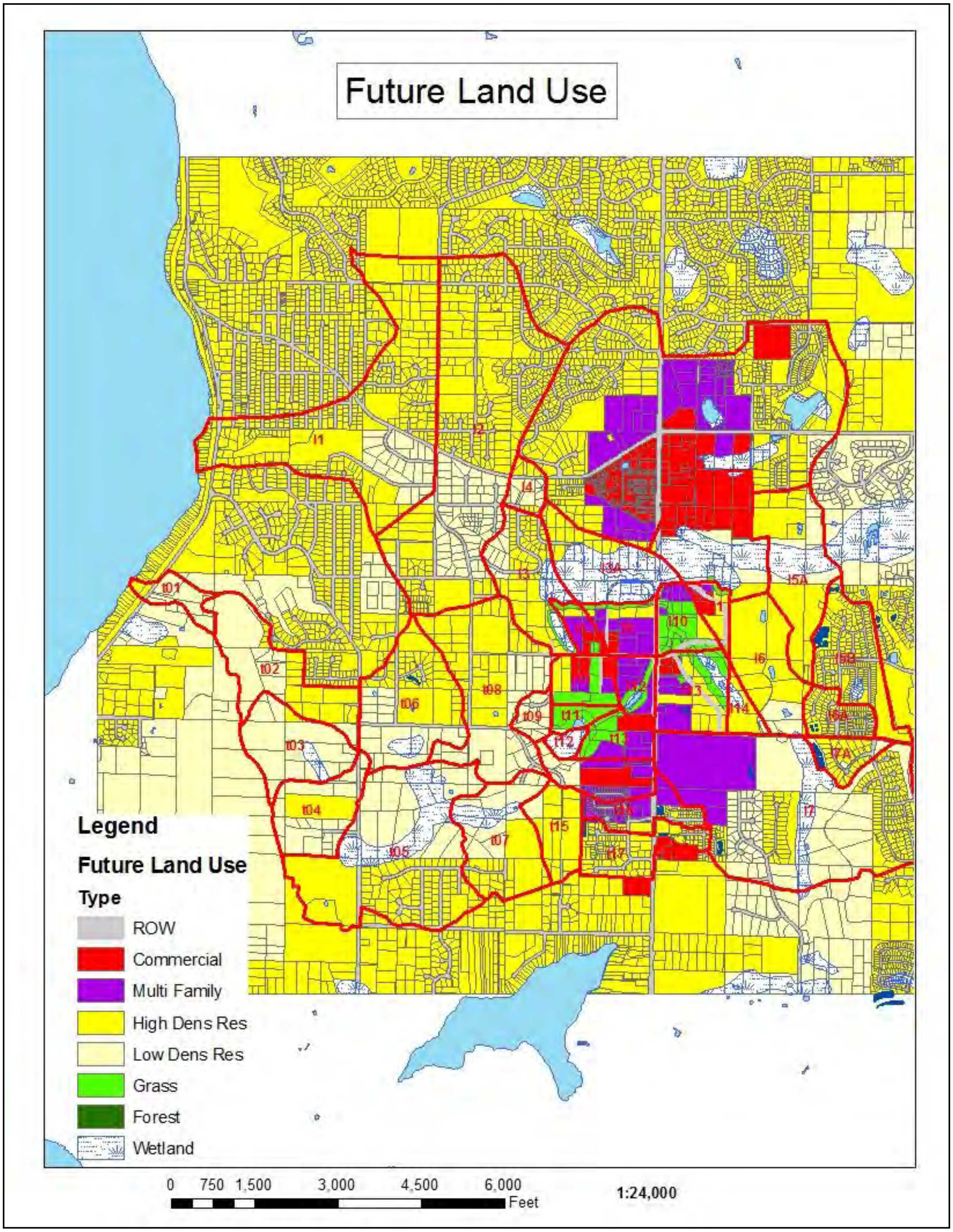


Figure 3 – Inglewood and Thompson Basins, Future Land Use, Developed from City of Sammamish Zoning and Town Center Plan

GEOLOGY

The Inglewood Basin consists of a broad till-capped plateau drained by gently sloping channels. The watershed geology was obtained from King County Department of Natural Resources[8] (Figure 4). The main stream channel flows across recessional outwash deposits incised into the till. Runoff generated on the adjacent till areas must migrate through the outwash before reaching the stream channel. In locations where the perched water table remains near the surface, several wetlands have formed. In the central portion of the watershed (Subbasins I2, I3, and I4), the groundwater is relatively deep, and the stream channel remains dry the majority of the time. Downstream of this point, the stream flows through an incised ravine and drops approximately 300 feet in less than a mile to Lake Sammamish. The lower stream reaches in Subbasin I1 receive discharge from the regional groundwater, which provides a reliable source of base flow to the stream throughout the year.

The Thompson basin is similar to Inglewood in that it originates in uplands of the Sammamish Plateau and drains through a ravine to Lake Sammamish. The lower reaches of the stream also intersect the regional groundwater table, which supports a nearly constant base flow. The Thompson Basin differs geologically from Inglewood in that it does not have a deep outwash deposit that infiltrates runoff upstream of the ravine. The runoff response in Ebright Creek is dominated by a surface and interflow response, similar to many other watersheds in the Puget Lowland that are underlain by glacial till .

For hydrologic modeling purposes, each geologic association in the watershed was assigned to one of three categories; till, outwash, or wetland according to the HSPF modeling methodology developed by the USGS[3,7]. These were combined with surface cover categories consisting of urban grass, forest, wetland/saturated soils, and impervious to form the PERLND groups shown in Table 2.

Table 2 – HSPF Land Cover/Geology (PERLND) Combinations

HSPF PERLND	Land Characteristics
Till Forest	Glacial till soils mature cover, all slopes
Till Urban Grass	Glacial till soils urban grass, all slopes Includes impervious surfaces not directly connected to the drainage network.
Outwash Forest	Glacial outwash soils mature cover, all slopes
Outwash Urban Grass	Glacial outwash soils urban grass, all slopes. Includes impervious surfaces not directly connected to the drainage network.
Wetland/Saturated Soils	Wetlands or areas with saturated soils
Impervious (HSPF IMPLND)	Impervious surfaces that are directly connected to the drainage network.

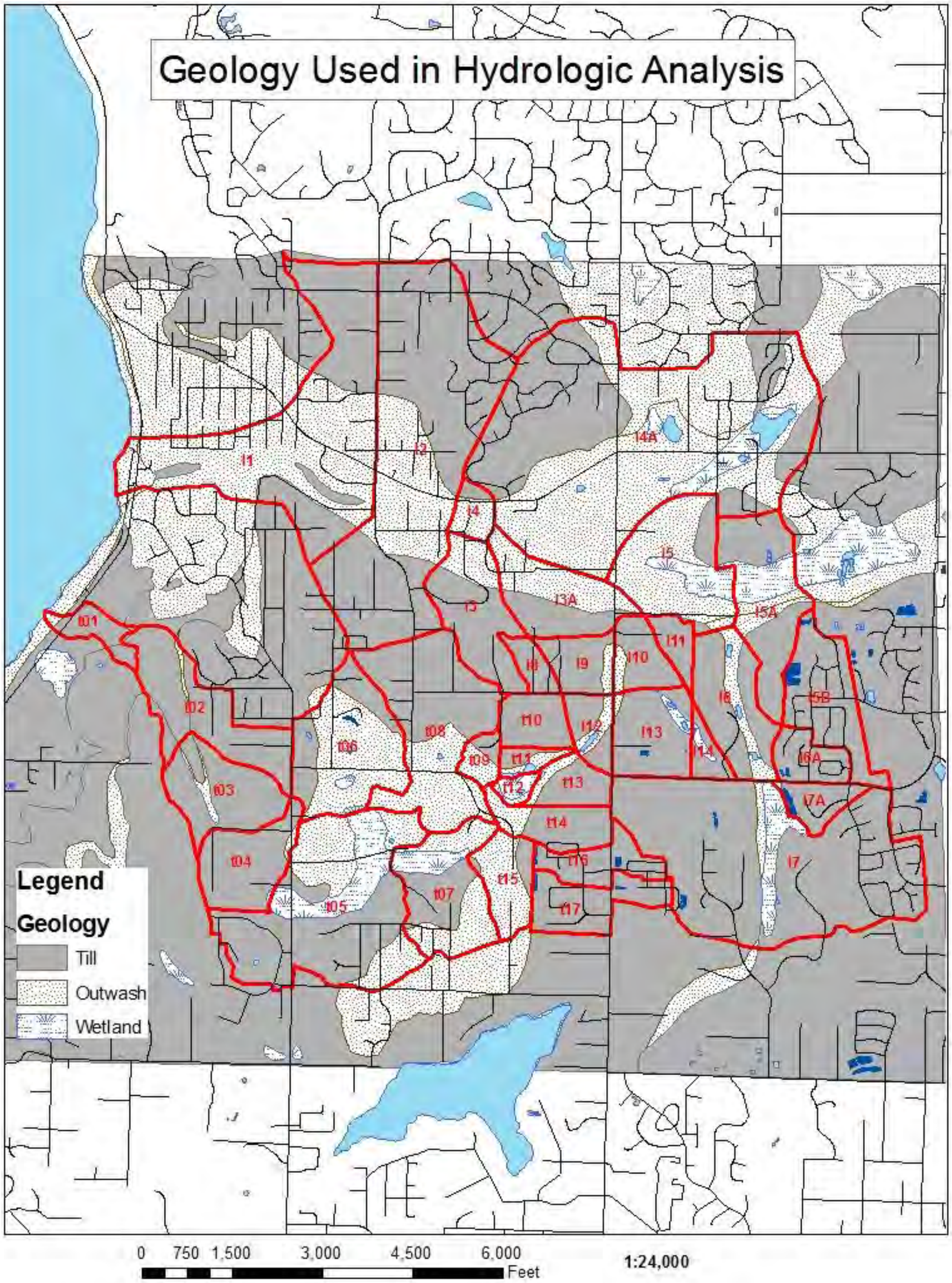


Figure 4 – Inglewood and Thompson Basins Geology as Defined for HSPF and MGSFlood Models

HSPF MODEL CONFIGURATION

INGLEWOOD BASIN

The geology of the Inglewood Basin consists of till in the uplands with glacial outwash in the ravine that carries the stream channel. Surface runoff and interflow produced in the upland till areas is infiltrated as it flows across the outwash deposit and results in a markedly attenuated runoff response from the watershed.

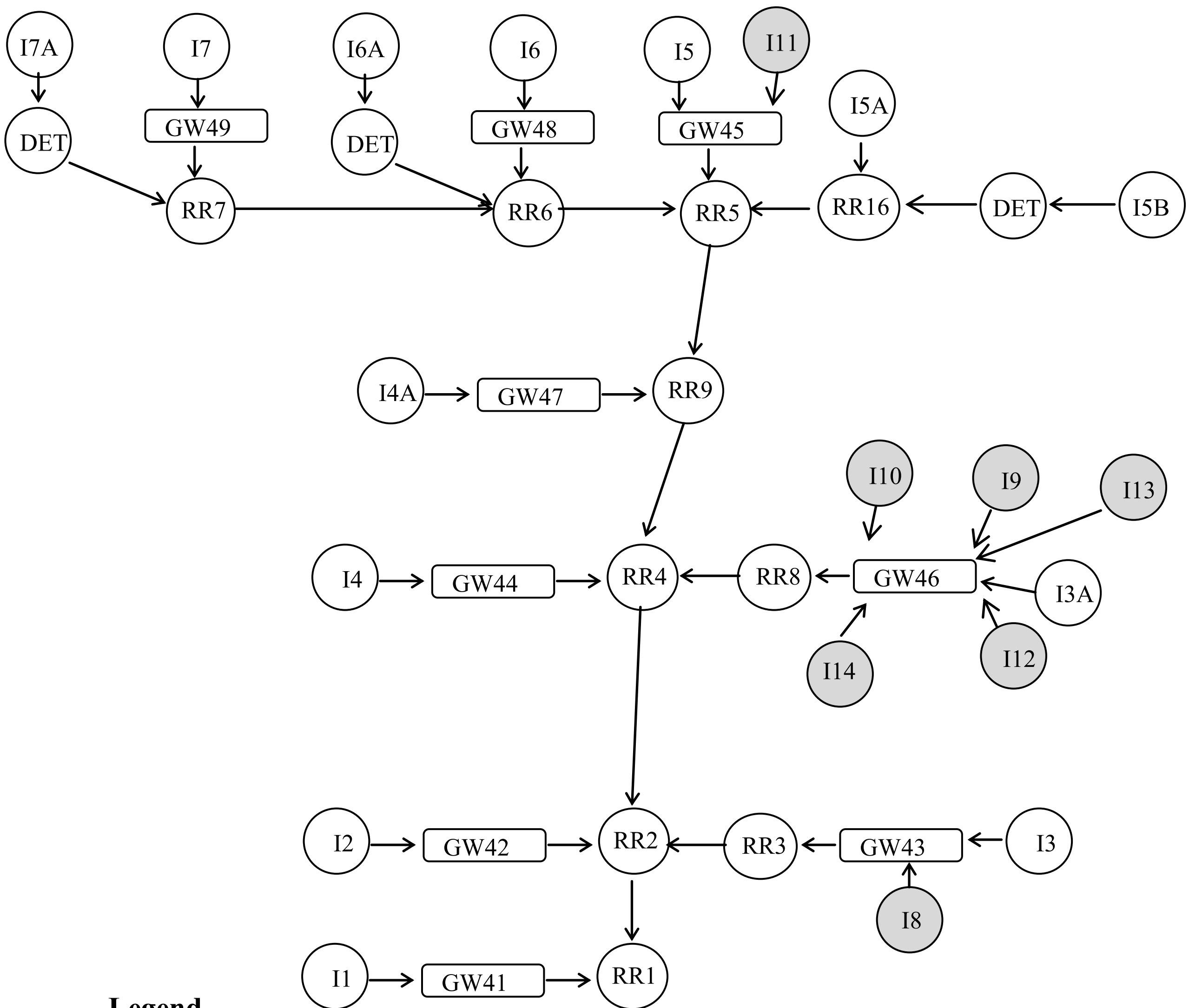
To mimic the infiltration of runoff from the uplands into the outwash deposit as they flow through George Davis Creek, a separate outwash Pervious Land Segment (PERLND) was defined for each subbasin that represents moisture inputs from both precipitation falling on the surface of the outwash and from lateral inflow from the till uplands. The area of these groundwater PERLNDS is equal to the area of outwash within the subbasin. The surface runoff and interflow from the adjacent upland till areas were then connected to each groundwater PERLND which were then connected to the stream channel.

Several large residential developments were constructed in the upper watershed in the time since the King County East Lake Sammamish Basin Plan was completed. The stormwater detention facilities associated with these developments were included in the HSPF model developed for the present analysis. Subbasin I5B, I6A, and I7A were added and define the tributary area to each stormwater pond associated with the new residential development. The ponds were designed according to the King County[9] Level 2 standard and HSPF routing tables (FTABLES) were developed for each subbasin such that they represented the detention pond discharge characteristics in the subbasin. A schematic of the Inglewood Basin HSPF model configuration is shown in Figure 5.

The USGS calibrated the HSPF model to the Inglewood Basin as part of a study to develop and validate regionalized parameters for the HSPF model for use in western Washington[3,7]. The USGS simulated the flow attenuation caused by the outwash using the HSPF channel routing (RCHRES) routine. They added flood storage volume to the stream reaches in each subbasin until the simulated and gaged streamflows matched. This approach produced a reasonable calibration but was not used in the present analysis because it was thought to be less physically representative of the watershed than the approach used (described above). The flood storage volume in the USGS model totaled approximately 7,000 acre-feet, which indicates that 7,000 acre-feet of stormwater detention storage would be required to replicate the flood storage and attenuation provided naturally by the outwash deposit.

Because of the high level of flood attenuation provided by the outwash deposit, the flow attenuation resulting from on-site detention in the future land use scenario would be indistinguishable after routing through the outwash deposit. In addition, connecting upstream stormwater ponds to the downstream groundwater PERLNDS can produce erroneous results in HSPF. Therefore, on-site detention mitigation was only included for the Town Center subbasins in the HSPF model. This does not mean that on-site detention should not be required in future developments in the Inglewood Basin; on the contrary, on-site detention should be required for future developments to ensure that discharge rates reaching the outwash do not increase to the point where they overwhelm the infiltration rate of the outwash deposit. This would result in a dramatic increase in the discharge rate in George Davis Creek as surface runoff in excess of the outwash infiltration rate discharged downstream.

The MGSFlood model was developed with routing reaches to account for the infiltration into the groundwater. The hydraulic characteristics of the routing reaches were defined to produce a response similar to the groundwater PERLNDS developed for the HSPF model. This approach allowed for detention to be included in all subbasins in the MGSFlood Inglewood model. For this reason, peak flow and duration results in the future land use scenario are slightly lower in the MGSFlood model than the HSPF model.



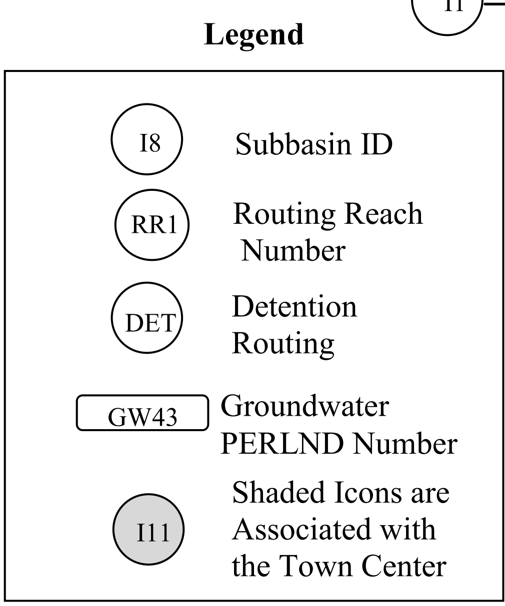
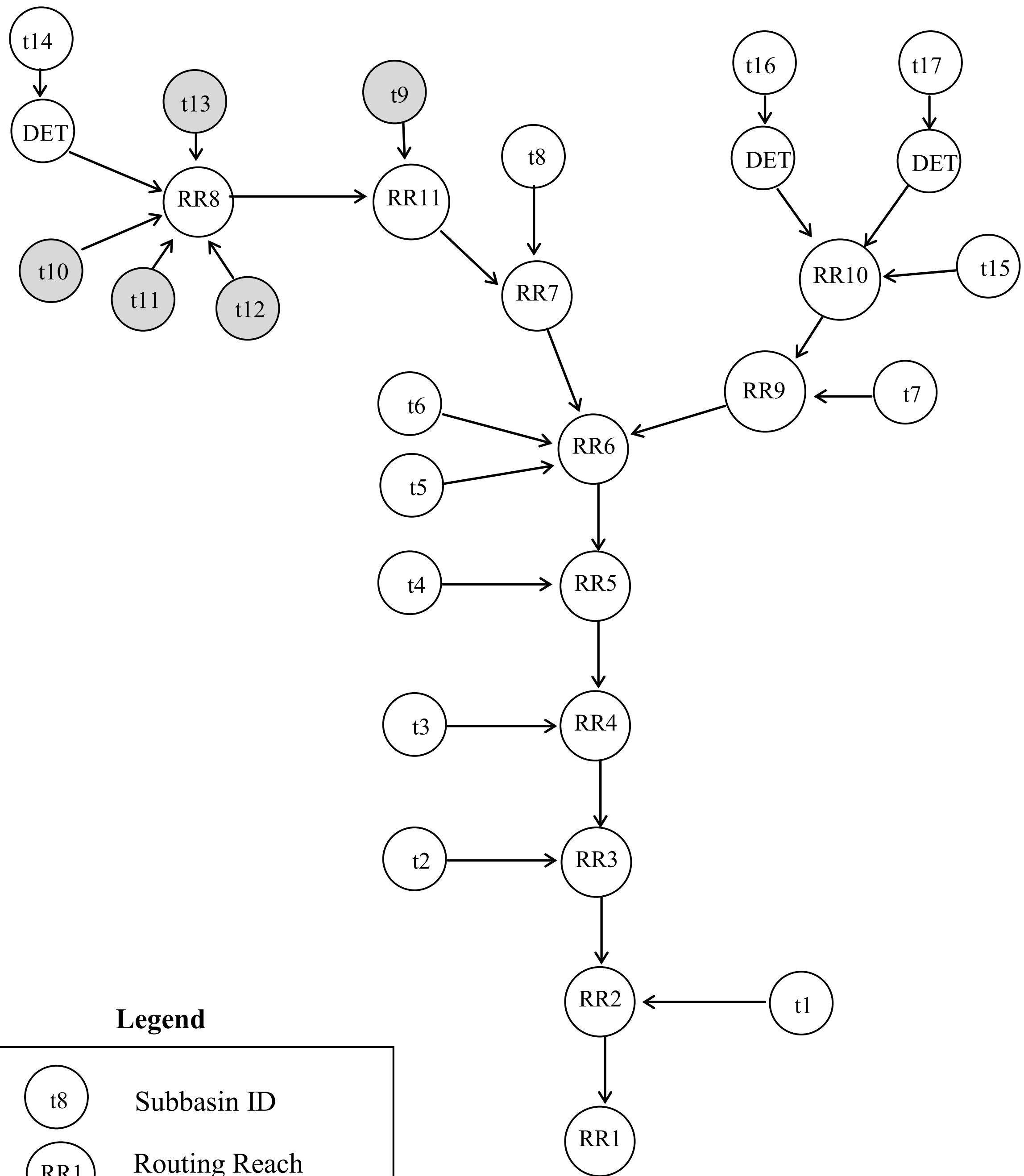


Figure 5 – Inglewood Basin HSPF Model Schematic

THOMPSON BASIN

The Thompson Basin is similar to Inglewood in that it originates in uplands of the Sammamish Plateau and drains through a ravine to Lake Sammamish. The Thompson Basin differs geologically from Inglewood in that it does not have a deep outwash deposit that infiltrates runoff upstream of the ravine. The runoff response in Ebright Creek is similar to many other watersheds in the Puget Lowland that are underlain by glacial till. Thus, routing through the outwash deposit was not included for this basin. While Ebright Creek does not possess the natural infiltration and storage of the outwash, it does have a large wetland (Wetland 17) situated at the top of the ravine. This 30-acre wetland provides substantial flood attenuation and buffering of flows entering from the uplands before discharging to the ravine.

Several existing developments in the upper washed were broken out as separate subbasins (Subbasins t16 and t17) and detention was included using the King County[9] Level 2 standard. A schematic of the Thompson Basin HSPF model configuration is shown in Figure 6.



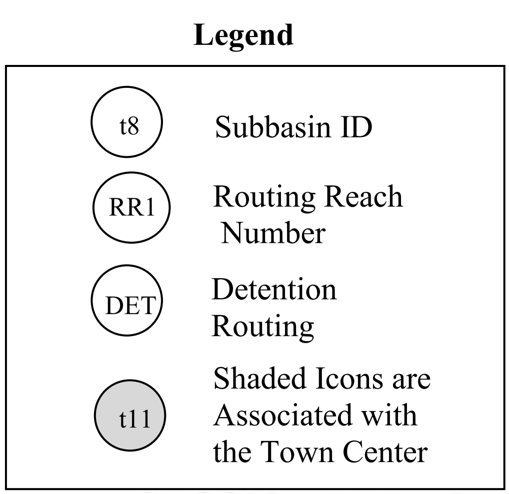


Figure 6 – Thompson Basin HSPF Model Schematic

Stormwater Detention Simulation

Future land use was simulated with detention according to the City's proposed on-site detention standard. This standard is based on the current King County design manual[10], which requires that the post development runoff duration is controlled to the predeveloped forest duration from ½ of the predeveloped 2-year to the 50-year. Two detention ponds were included for each subbasin; one for areas on glacial till and one for areas on outwash. The outwash areas were sized as infiltration basins and only the overflow was connected to the receiving stream.

To account for uncertainty due to design, construction, and maintenance, detention mitigation simulated with the future land use scenario was assumed to be 90-percent effective. This was accomplished by sizing detention for only 90-percent of the developed area and routing 90-percent of the area to the pond. The remaining 10-percent of the developed area bypassed the pond. The exception was in the Town Center area where the bypass was not applied because this is a master planned development, and the design, construction, and maintenance will likely be more reliable than a typical development.

HSPF MODEL CALIBRATION

INTRODUCTION

Calibration of the HSPF model was performed to ensure that the hydrologic processes simulated by the model were representative of the conditions in the watershed. Calibration is the process whereby the model input parameters are adjusted until simulated and recorded discharge data match to the greatest extent possible.

CALIBRATION DATA

The model parameters were refined through calibration using streamflow data collected near the mouth of George Davis Creek and concurrent precipitation collected near the headwaters (City of Sammamish Gage 18Y) for the period October 2001-May 2003. Daily evaporation data were developed from data collected at the Puyallup 2 West Experimental Station (station number 45-6803). Flow data at the mouth of Ebright Creek were not of sufficient quality to use in model calibration.

Streamflow data for Ebright Creek was collected at a gage operated by commercial firm, Geotivity under contract to the City of Sammamish. Geotivity went bankrupt several years ago, and maintenance of the gage and quality checking of the data ceased at that time. The flow gage consisted of a sensor that tracked, among other things, the flow depth and velocity. Flow rate was computed using a functional relationship that included the recorded depth and velocity. This metering approach is commonly used in storm and sanitary sewers where the velocity varies across the flow area in a predictable manner. In stream channels, the cross section is irregular in shape and the velocity varies in a much less predictable manner.

The relationship used by Geotivity to derive streamflow from the depth and velocity measurements was not known. The data were analyzed and several relationships were tried to convert the depth and velocity measurements to discharge. The resulting flow data did not appear reasonable when compared with precipitation data recorded in the watershed.

An apparent shift in the depth recordings was also noted following a large storm that occurred in December 2007. Following the storm, the base flow depth recorded by the meter was higher, and resulted in a 1-2 cfs increase in the flow data than prior to the storm.

Because of the issues cited above, the recorded streamflow at the mouth of Ebright Creek were not used to calibrate the models. Parameters derived from the Inglewood Basin calibration were used for the Thompson Basin. Plots comparing simulated and recorded streamflow at the Ebright Creek gage are presented in the next section. The flow rate at the Ebright gage was derived by multiplying the recorded velocity times the cross sectional area corresponding to the recorded depth.

HSPF MODEL CALIBRATION RESULTS

Existing land use (year 2006) was used for model calibration. Model parameters for the pervious land segments (PERLNDS) were adopted from the 2004 Inglewood Basin Plan update[11]. Hourly streamflow data recorded by the City of Sammamish from October 2001-May 2003 near the outlet of George Davis Creek was used to verify that the current model with updated land use and subbasins produced results similar to the original calibration.

A comparison of simulated and recorded discharge at the outlet of George Davis Creek during water years 2002 and 2003 is shown in Figure 7. In general, the simulated and recorded magnitude and timing of discharge compared well. The general shape of simulated winter storm flows and the magnitude of summer base flows matched well with the recorded streamflow for this period. Several large runoff spikes in the streamflow record (December 2001, October 2002, and March 2003) were attributed to gage malfunction or poor quality data and were discounted in the model calibration. The streamflow record was not of sufficient quality to compute runoff volume or other statistics. The calibration was therefore judged qualitatively by the goodness of fit between simulated and recorded streamflow shown in Figure 7.

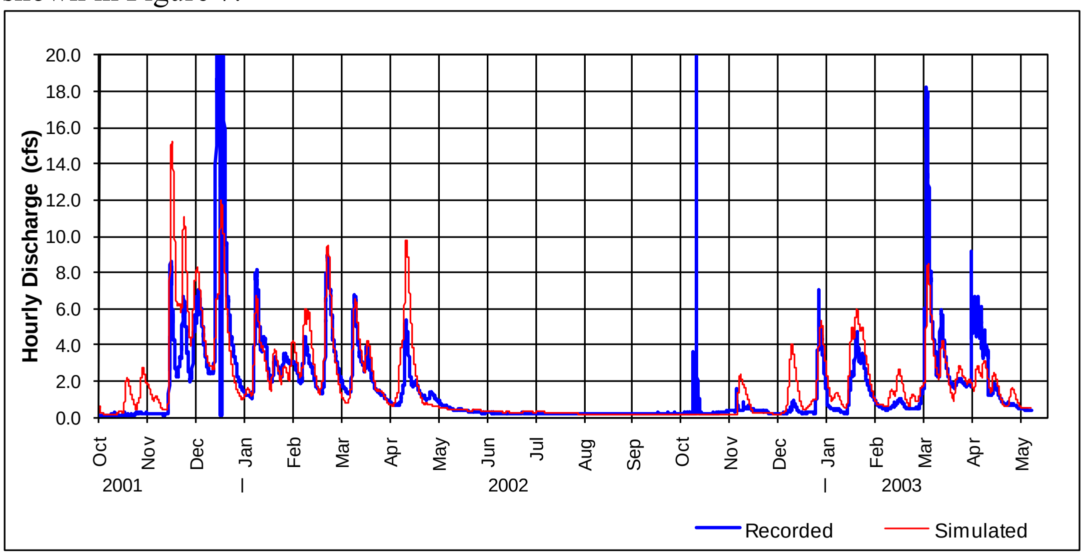


Figure 7 – HSPF Model Calibration, George Davis Creek

As discussed in the previous section, flow data at the mouth of Ebright Creek were deemed of insufficient quality to warrant use in the model calibration. Despite the uncertainty with the recorded streamflow data, there is a fairly close correspondence between the simulated and recorded flows (Figure 8), especially the storm that occurred in December 2007 (Figure 9).

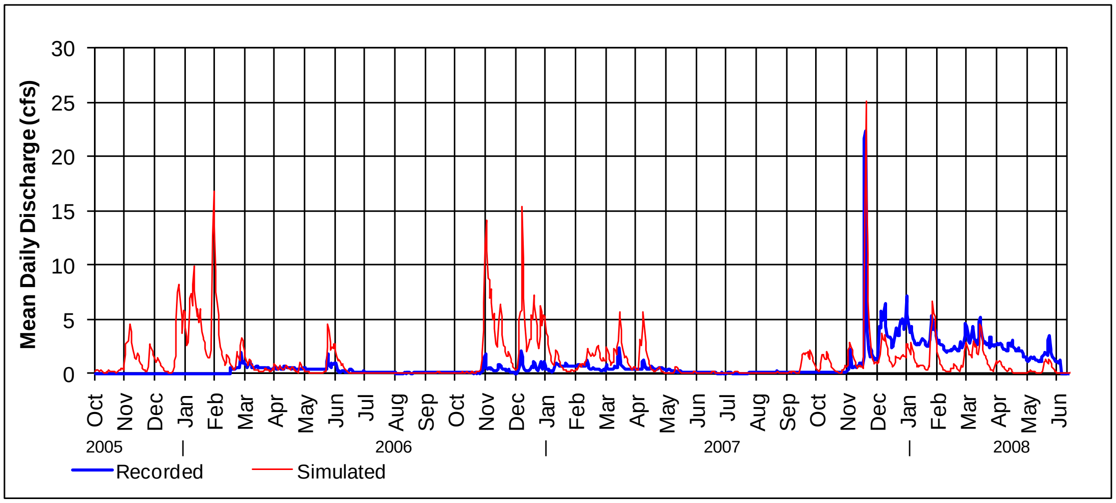


Figure 8 – Comparison of Simulated and Recorded Flow at Mouth of Ebright Creek
(Note: Gage not used for Calibration due to data Quality Concerns)

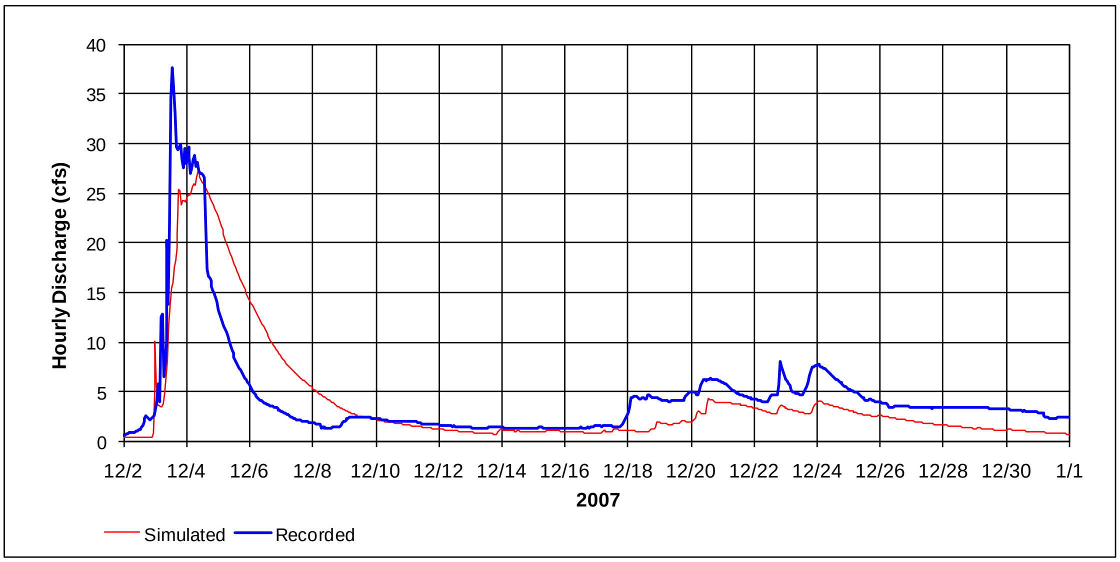


Figure 9 – Comparison of Simulated and Recorded Flow at Mouth of Ebright Creek December 2007 Storm
(Note: Gage not used for Calibration due to data Quality Concerns)

TOWN CENTER ANALYSIS USING THE MGSFLOOD MODEL

MGSFlood[2] is a continuous rainfall runoff model used for stormwater facility analysis and design. The model uses the same rainfall-runoff algorithms as HSPF but includes routines for sizing stormwater detention facilities and simulating LID measures. MGSFlood model input was developed for both the Inglewood and Thompson Basins using the same land use, soil type, hydraulic routing, and runoff parameters used in the HSPF model. This approach allowed for numerous stormwater mitigation measures to be analyzed, especially in the Town Center basins. Simulation results for the Town Center alternatives are presented in the Town Center Comprehensive Stormwater Plan.

An additional benefit of the MGSFlood model is that it is much easier to use compared with HSPF. The MGSFlood model can be used in the future by City staff or their consultants to analyze changes to the Town Center plan or other developments in the watersheds and analyze the effects of the changes in a basin-wide context.

HSPF WATERSHED MODEL – ANALYSIS/PREDICTION APPROACH

SIMULATION PERIOD

Following the calibration phase, the model may be used for analysis and prediction of streamflows for various land use conditions. For this application, long-term, high-quality, precipitation timeseries are needed that are representative of the hourly, daily, weekly and monthly precipitation characteristics that have occurred in the past, and can be expected to occur in the future.

The Washington State Department of Transportation, Extended Precipitation Timeseries for Continuous Hydrologic Modeling[12,13] was used as input for the analysis of the Inglewood and Thompson Basins. This timeseries has a 1-hour timestep, is 158-years in length, and represents the rainfall characteristics of the basins (48 inches mean annual precipitation).

PEAK FLOW MAGNITUDE-FREQUENCY STATISTICS

Peak discharge magnitude-frequency estimates were computed at locations of interest in the watersheds using the HSPF model. The annual maxima discharge rates were saved at each location from the 158-years simulated. Peak flow and elevation magnitude-frequency relationships were computed using the Gringorten[14,15] plotting position formula (Equation 1).

$$Tr = \frac{N + 0.12}{i - 0.44} \qquad (1)$$

Where: *Tr* is the recurrence interval of the peak flow,
i is the rank of the annual maxima peak flow ordered from highest to lowest,
N is the total number of years simulated (158 in this case).

FLOW DURATION STATISTICS

Modifications to the land surface during urbanization increase both the runoff peak rate and volume. The increase in runoff volume is the result of the loss of water storage in the soil column because of the compaction of the soil and the introduction of impervious surfaces. Figure 10 compares the allocation of precipitation falling on a forested and an urban watershed. In the forested watershed, the precipitation ends up nearly all evaporation and infiltration with very little surface runoff. With an urban watershed, the evaporation and infiltration are reduced significantly, and a much higher percentage of the rainfall ending up as surface overland flow.

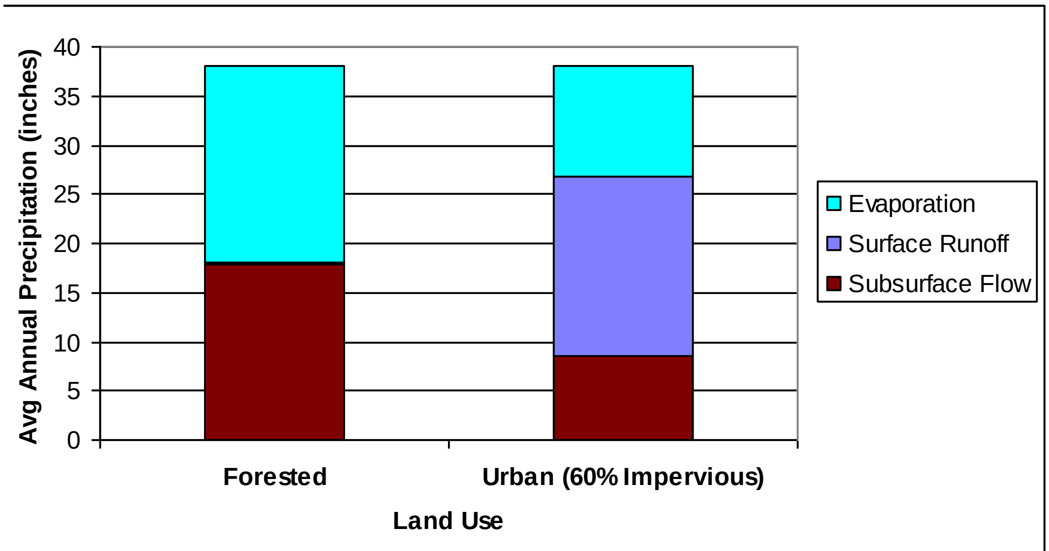


Figure 10 – Mean Annual Precipitation Water Budget for a Forested and Urban Site

The increase in runoff volume combined with the increase in runoff rate results in higher stream discharges occurring for a <u>longer duration</u>. The increase in duration of a given flow rate results in more erosive work on the stream channel over time, particularly when the discharge rate exceeds the threshold for streambed movement in the receiving channel.

Flow duration statistics provide a convenient tool for characterizing streamflow computed with a continuous hydrologic model. Duration statistics are computed by tracking the fraction of time that a specified flow rate is equaled or exceeded. HSPF does this by dividing the range of flows simulated into discrete increments and then tracks the fraction of time that each flow is equaled or exceeded. The fraction of time that a particular flow is equaled or exceeded is called *exceedance probability*. It should be noted that exceedance probability for duration statistics is different from the *annual exceedance probability* associated with flood frequency statistics and there is no practical way of converting/relating annual exceedance probability statistics to flow duration statistics.

FLOOD FREQUENCY AND FLOW DURATION RESULTS

INTRODUCTION

Precipitation timeseries 158-years in length at a 1-hour timestep and daily evaporation derived from the Puyallup 2 West Experimental Station (station number 45-6803) were used as input to the model, which resulted in a 158-year, 1-hour timeseries of flow at the outlet of each subbasin simulated. Flood magnitude-frequency and duration analyses were subsequently performed on the flow timeseries at locations of interest in the watershed.

The future land use scenarios were simulated with stormwater mitigation designed according to the City's proposed stormwater detention ordinance[10]. The simulation results presented in this section provide an assessment of the performance of stormwater mitigation in a basin-wide context. Details on mitigation options for the Town Center that includes Low Impact Development as well as traditional stormwater detention, is presented in the Town Center Comprehensive Stormwater Plan.

FLOOD PEAK DISCHARGE RESULTS

Increases in peak discharge rates under future conditions in the Inglewood Basin are negligible in most areas and actually decrease other areas relative to the existing land use scenario (Figures 11a, 11b, and Tables 3a, 3b, and 3c). The reason for the small change in discharge rate is the presence of the glacial outwash deposit, which infiltrates the majority of surface runoff produced in the till capped uplands. As discussed in the model calibration section, the outwash deposit is equivalent to approximately 7,000 acre-feet of stormwater detention storage in the Inglewood Basin.

While natural infiltration of the outwash in the central portion of the watershed provides substantial natural buffering of the runoff under the future land use, on-site detention and LID controls are still necessary to ensure that runoff rates associated with future development do not overwhelm the infiltration capacity in the channels underlain by outwash.

Peak runoff rates in the Thompson Basin show a greater reduction in the future flows relative to existing conditions (Figures 12a, 12b and Tables 4a and 4b). This is because there are many developments in the basin with little or no stormwater controls and the Thompson Basin does not contain the infiltrative outwash present in the Inglewood Basin to mitigate runoff from existing development.

Peak runoff rates in the Town Center subbasins show a dramatic reduction in peak flows under future conditions relative to existing conditions in the majority of subbasins (Figures 13a, 13b, and Tables 5a, and 5b). In most areas, the peak discharge under future land use conditions is reduced to rates comparable to the forested land use condition.

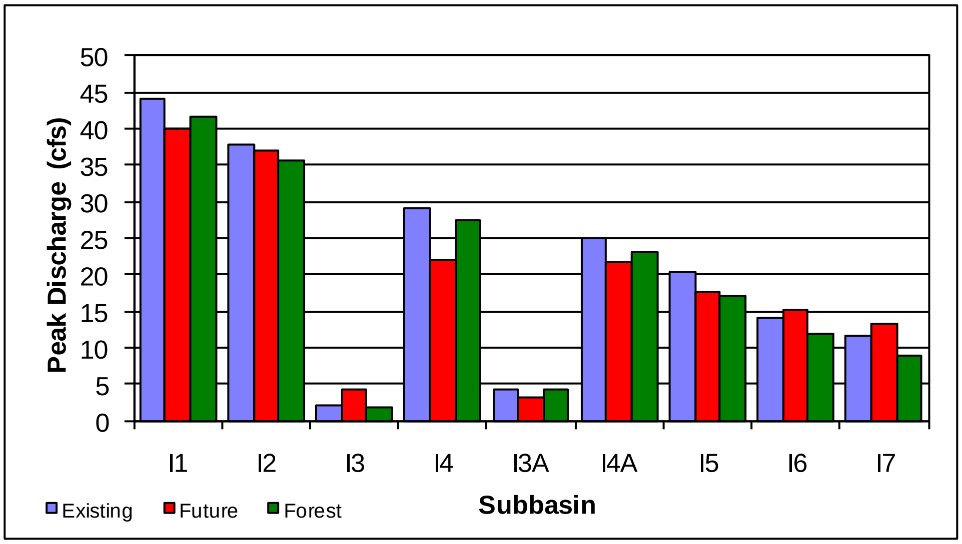


Figure 11a – George Davis Creek, Comparison of 100-Year Flood Peak Discharge Existing, Future, and Forested Land Use

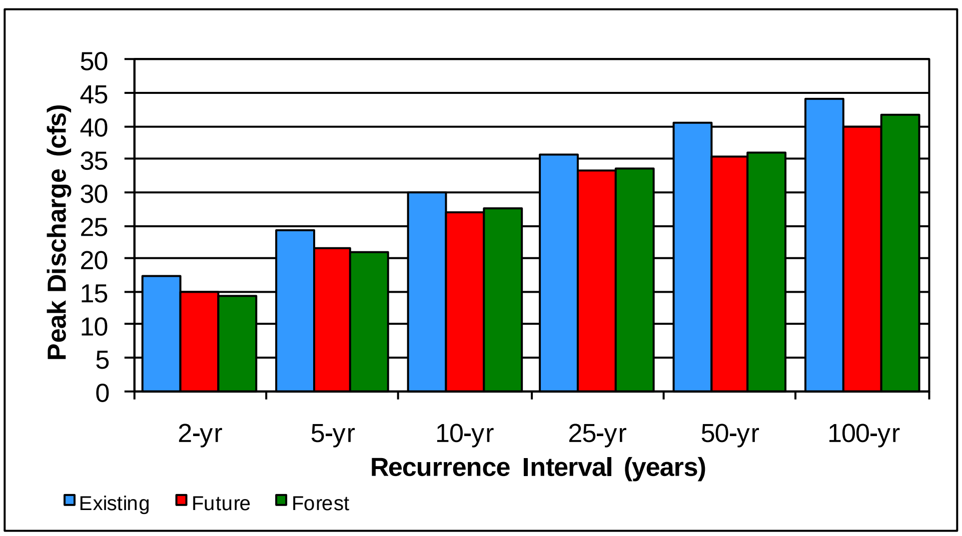


Figure 11b – Comparison of Flood Peak Discharge at Mouth of George Davis Creek (Inglewood Basin) Existing, Future, and Forested Land Use

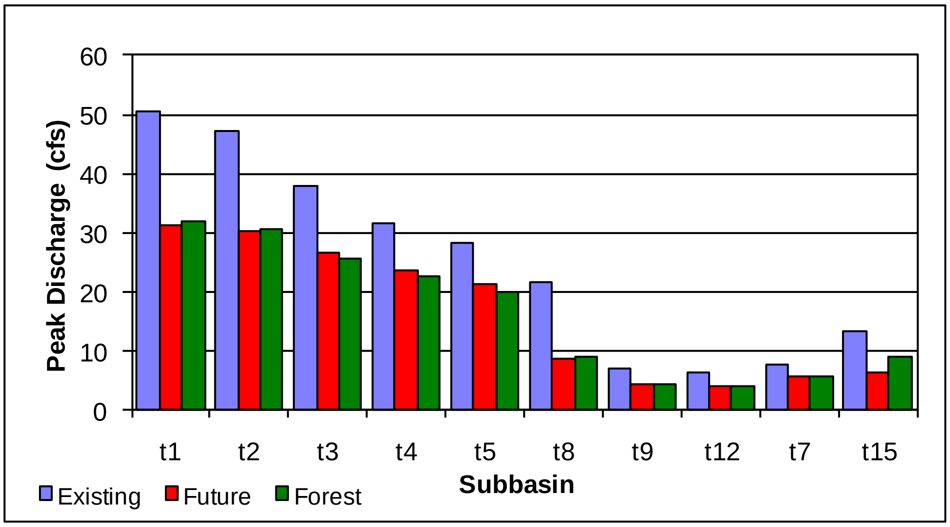


Figure 12a – Ebright Creek, Comparison of 100-Year Flood Peak Discharge Existing, Future, and Forested Land Use

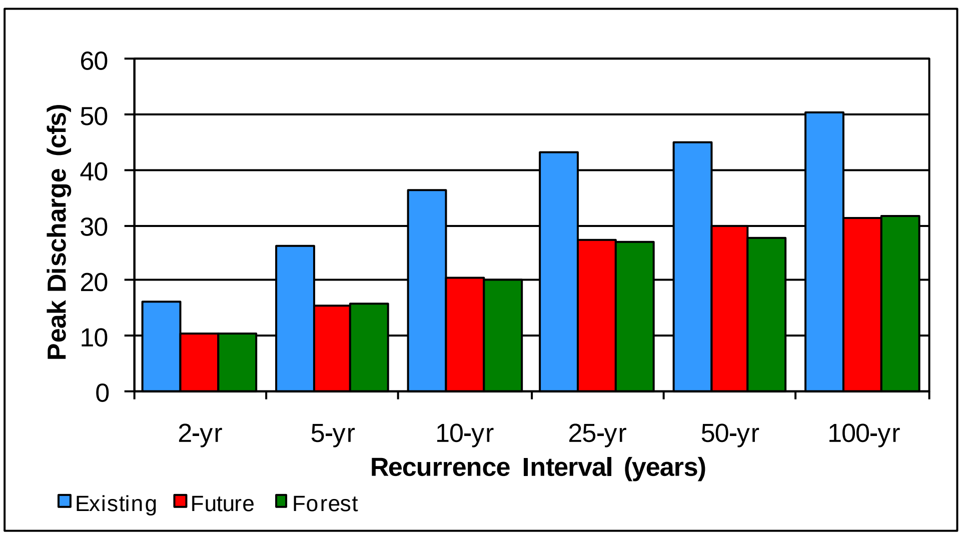


Figure 12b – Comparison of Flood Peak Discharge at Mouth of Ebright Creek (Thompson Basin) Existing, Future, and Forested Land Use

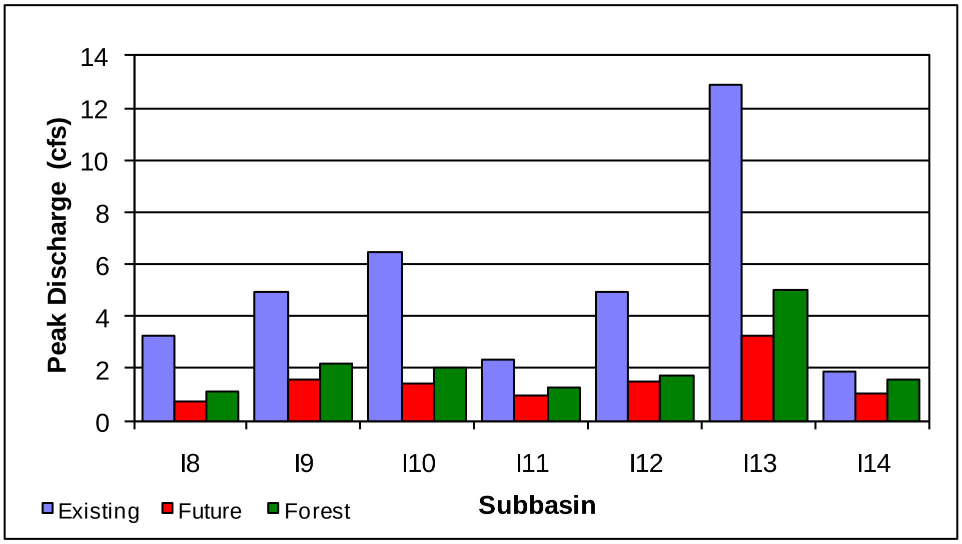


Figure 13a – Town Center Subbasins in the Inglewood Basin, Comparison of 100-Year Flood Peak Discharge
Existing, Future, and Forested Land Use

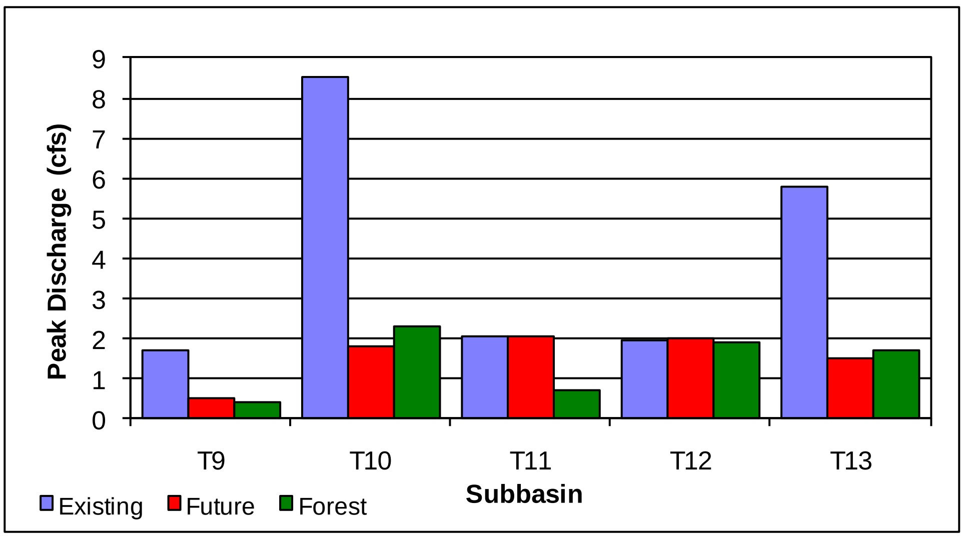


Figure 13b – Town Center Subbasins in the Thompson Basin, Comparison of 100-Year Flood Peak Discharge
Existing, Future, and Forested Land Use

Table 3a – Inglewood Basin Flood Magnitude-Frequency Estimates (cfs) Existing Land Use (2006) (Discharge is Referenced to Subbasin Outlet)						
	Flood Magnitude-Frequency Estimates (cfs)					
Subbasin	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN I1	17	24	30	36	40	44
SUBBASIN I2	15	20	26	31	35	38
SUBBASIN I3	0.9	1.1	1.4	1.7	1.8	1.9
SUBBASIN I4	12	16	20	24	27	29
SUBBASIN I3A	1.9	2.5	3.1	3.7	4.0	4.2
SUBBASIN I4A	10	14	17	21	23	25
SUBBASIN I5	8.3	11	14	17	18	20
SUBBASIN I6	6.1	7.8	10	12	13	14
SUBBASIN I7	4.9	6.4	8.3	10	11	12

Table 3b – Inglewood Basin Flood Magnitude-Frequency Estimates (cfs) Future Land Use with Mitigation (Discharge is Referenced to Subbasin Outlet)						
	Flood Magnitude-Frequency Estimates (cfs)					
Subbasin	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN I1	15	21	27	33	35	40
SUBBASIN I2	12	18	22	28	29	37
SUBBASIN I3	0.5	0.7	1.1	2.4	2.6	4.3
SUBBASIN I4	10	13	16	19	20	22
SUBBASIN I3A	0.2	0.3	0.4	2.1	2.6	3.2
SUBBASIN I4A	10	13	16	18	20	22
SUBBASIN I5	7.7	10	12	15	16	18
SUBBASIN I6	6.6	8.7	11	14	14	15
SUBBASIN I7	5.8	7.7	10	12	12	13

Table 3c – Inglewood Basin Flood Magnitude-Frequency Estimates (cfs) Forested Land Use (Discharge is Referenced to Subbasin Outlet)						
	Flood Magnitude-Frequency Estimates (cfs)					
Subbasin	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN I1	14	21	28	34	36	42
SUBBASIN I2	12	17	23	29	31	36
SUBBASIN I3	0.7	0.9	1.3	1.6	1.7	1.9
SUBBASIN I4	11	14	19	23	24	27
SUBBASIN I3A	1.6	2.1	2.8	3.5	3.8	4.1
SUBBASIN I4A	8.9	12	16	19	21	23
SUBBASIN I5	6.6	8.8	12	14	15	17
SUBBASIN I6	4.4	5.8	7.9	10	11	12
SUBBASIN I7	3.3	4.3	5.9	7.4	8.0	8.9

Table 4a – Thompson Basin Flood Magnitude-Frequency Estimates (cfs) Existing Land Use (2006) (Discharge is Referenced to Subbasin Outlet)						
	Flood Magnitude-Frequency Estimates (cfs)					
Subbasin	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN t1	16	26	36	43	45	51
SUBBASIN t2	15	25	34	39	42	47
SUBBASIN t3	13	19	24	30	35	38
SUBBASIN t4	11	15	21	27	30	31
SUBBASIN t5 WL17	10	13	19	24	26	28
SUBBASIN t8	6.4	10	15	20	21	22
SUBBASIN t9	2.2	3.1	4.2	6.0	6.4	6.8
SUBBASIN t12 WL61	2.1	2.9	3.9	5.6	6.0	6.3
SUBBASIN t7	3.0	4.2	5.4	7.1	7.4	7.7
SUBBASIN t15	3.5	5.4	7.1	10	11	13

Table 4b – Thompson Basin Flood Magnitude-Frequency Estimates (cfs) Future Land Use with Mitigation (Discharge is Referenced to Subbasin Outlet)						
	Flood Magnitude-Frequency Estimates (cfs)					
Subbasin	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN t1	10	15	21	27	30	31
SUBBASIN t2	10	15	20	27	29	30
SUBBASIN t3	8.6	13	17	23	25	26
SUBBASIN t4	7.7	11	15	20	22	24
SUBBASIN t5 WL17	6.8	10	13	18	20	21
SUBBASIN t8	2.7	4.2	5.4	7.3	8.3	8.5
SUBBASIN t9	1.2	1.9	2.6	3.5	3.8	4.2
SUBBASIN t12 WL61	1.1	1.8	2.4	3.3	3.6	4.0
SUBBASIN t7	1.8	2.7	3.8	4.9	5.4	5.6
SUBBASIN t15	2.3	3.2	4.4	5.6	5.9	6.3

Table 4c – Thompson Basin Flood Magnitude-Frequency Estimates (cfs) Forested Land Use (Discharge is Referenced to Subbasin Outlet)						
	Flood Magnitude-Frequency Estimates (cfs)					
Subbasin	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN t1	10	16	20	27	28	32
SUBBASIN t2	10	15	19	26	26	31
SUBBASIN t3	7.9	12	16	21	22	26
SUBBASIN t4	6.9	10	14	18	20	22
SUBBASIN t5 WL17	6.1	8.7	12	16	17	20
SUBBASIN t8	2.8	4.5	5.8	7.9	8.1	9.0
SUBBASIN t9	1.2	1.6	2.5	3.3	3.6	4.2
SUBBASIN t12 WL61	1.1	1.6	2.3	3.1	3.4	3.9
SUBBASIN t7	2.0	2.7	3.7	4.7	5.0	5.6
SUBBASIN t15	2.1	3.7	4.6	6.2	7.3	8.8

Table 5a – Town Center Flood Magnitude-Frequency Estimates (cfs) Existing Land Use (2006) (Discharge is Referenced to Subbasin Outlet)						
Subbasin	Flood Magnitude-Frequency Estimates (cfs)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN I8	0.72	1.19	1.63	2.52	2.61	3.22
SUBBASIN I9	1.37	2.12	2.88	3.84	4.03	4.91
SUBBASIN I10	1.52	2.40	3.25	5.10	5.47	6.43
SUBBASIN I11	0.61	1.02	1.47	1.87	2.03	2.32
SUBBASIN I12	1.20	1.89	2.52	3.86	4.08	4.96
SUBBASIN I13	3.41	5.16	6.84	9.78	10.37	12.93
SUBBASIN I14	0.52	0.84	1.02	1.35	1.51	1.87
SUBBASIN t9	0.46	0.69	0.91	1.35	1.56	1.70
SUBBASIN t10	2.14	3.24	4.27	6.78	7.53	8.51
SUBBASIN t11	0.47	0.76	1.05	1.60	1.70	2.04
SUBBASIN t12	0.64	0.92	1.11	1.37	1.52	1.93
SUBBASIN t13	1.28	2.08	2.85	4.60	5.02	5.77

Table 5b – Town Center Flood Magnitude-Frequency Estimates (cfs) Future Land Use with Mitigation (Discharge is Referenced to Subbasin Outlet)						
Subbasin	Flood Magnitude-Frequency Estimates (cfs)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN I8	0.20	0.35	0.50	0.66	0.73	0.74
SUBBASIN I9	0.47	0.75	1.09	1.41	1.54	1.56
SUBBASIN I10	0.38	0.61	0.87	1.22	1.36	1.43
SUBBASIN I11	0.28	0.44	0.64	0.82	0.91	0.98
SUBBASIN I12	0.73	0.89	1.04	1.31	1.37	1.51
SUBBASIN I13	0.87	1.42	1.88	2.61	2.89	3.25
SUBBASIN I14	0.32	0.46	0.60	0.78	0.87	1.00
SUBBASIN t9	0.27	0.33	0.39	0.46	0.49	0.50
SUBBASIN t10	0.61	0.88	1.20	1.61	1.66	1.78
SUBBASIN t11	0.46	0.76	1.05	1.61	1.71	2.05
SUBBASIN t12	0.66	0.94	1.14	1.39	1.55	1.98
SUBBASIN t13	0.64	0.81	1.09	1.37	1.44	1.47

Table 5c – Town Center Flood Magnitude-Frequency Estimates (cfs) Forested Land Use (Discharge is Referenced to Subbasin Outlet)						
Subbasin	Flood Magnitude-Frequency Estimates (cfs)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SUBBASIN I8	0.34	0.54	0.67	0.91	0.99	1.14
SUBBASIN I9	0.62	1.01	1.25	1.71	1.85	2.15
SUBBASIN I10	0.61	0.96	1.19	1.63	1.76	2.04
SUBBASIN I11	0.37	0.59	0.73	1.00	1.08	1.25
SUBBASIN I12	0.49	0.82	0.97	1.32	1.45	1.70
SUBBASIN I13	1.45	2.42	2.84	3.91	4.31	5.03
SUBBASIN I14	0.45	0.73	0.85	1.19	1.29	1.55
SUBBASIN t9	0.12	0.19	0.23	0.32	0.34	0.40
SUBBASIN t10	0.69	1.08	1.34	1.84	1.99	2.31
SUBBASIN t11	0.19	0.32	0.38	0.52	0.57	0.67
SUBBASIN t12	0.63	0.90	1.09	1.34	1.49	1.87
SUBBASIN t13	0.50	0.79	0.98	1.34	1.45	1.68

FLOW DURATION RESULTS

Flow duration statistics provide an indication of the relative amount of erosive work performed on the stream channel. The increase in duration at a given flow rate results in more erosive work being performed on the stream channel over time. As urbanization occurs in the watershed, the frequency of discharge that exceeds the historic bedload movement threshold increases. This results in greater erosive work on the stream channel leading to an expansion in the channel cross section and leads to larger sized stream gravel as the smaller gravel fraction is carried downstream.

Figures 14a and 14b compare flow duration statistics in the ravine area of George Davis and Ebright creeks, respectively and show a relatively small change in the flow duration statistics for future relative to existing land use. This suggests that under build-out conditions, the potential for increased stream channel erosion is relatively small. Again, this is due to the presence of highly infiltrative outwash in the central part of the watershed, which greatly reduces the surface runoff response from the watershed. Flow duration statistics for each subbasin are summarized in Tables 6a -6c for the Inglewood Basin and Tables 7a -7c for the Thompson Basin.

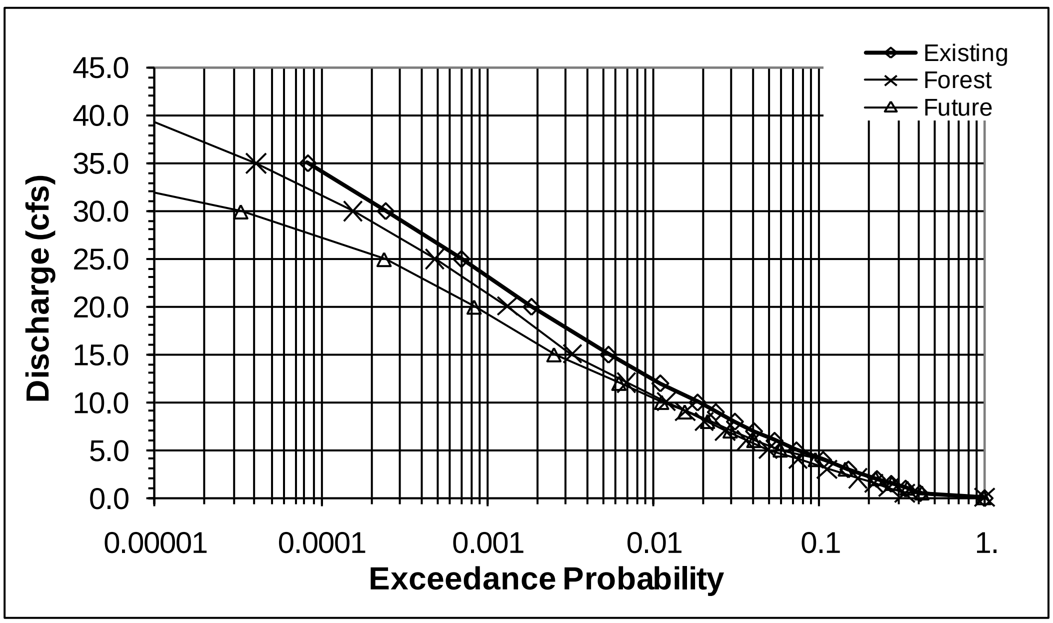


Figure 14a – Comparison of Simulated Flow Duration, Existing, Future, and Forest Land Use George Davis Creek, Inglewood Basin, Subbasin I2, Ravine

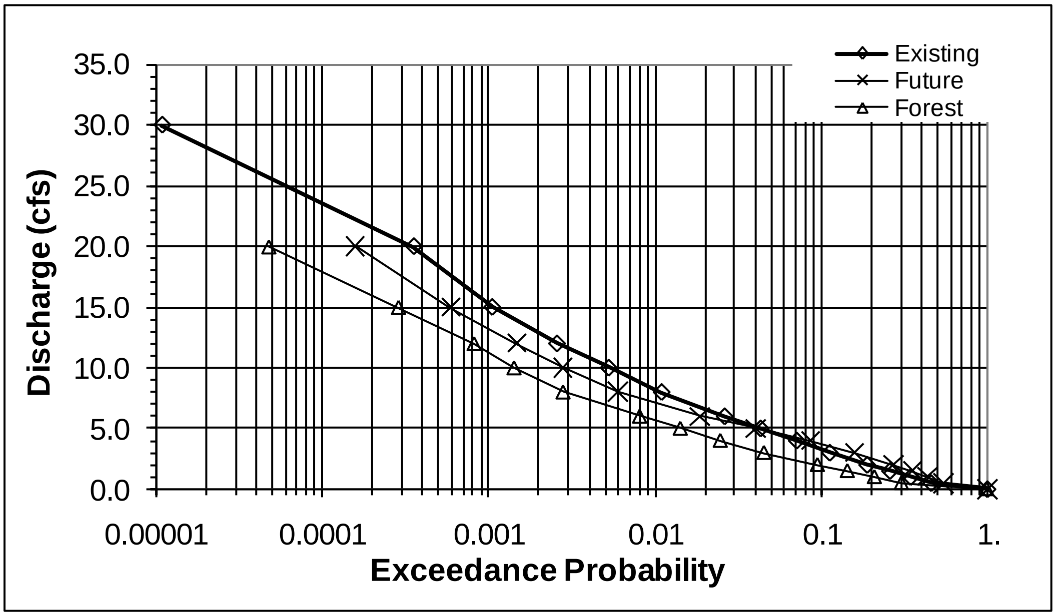


Figure 14b – Comparison of Simulated Flow Duration, Existing, Future, and Forest Land Use Ebright Creek, Thompson Basin, Subbasin t4, Ravine

Table 6a – Inglewood Basin Flow Duration Analysis Results, Existing Land Use

	Existing Land Use			
	Discharge Corresponding to Exceedance Probability (cfs)			
Subbasin	**90%**	**50%**	**20%**	**10%**
I1	0.10	0.78	3.47	5.78
I2	0.06	0.39	2.29	4.16
I3	0.02	0.11	0.25	0.35
I4	0.07	0.47	2.52	4.36
I5	0.06	0.41	1.64	2.83
I6	0.05	0.34	1.26	2.13
I7	0.05	0.32	1.03	1.74
I3A	0.03	0.19	0.45	0.70
I4A	0.07	0.45	2.14	3.64

Table 6b – Inglewood Basin Flow Duration Analysis Results, Future Mitigated Land Use

	Future Land Use Discharge Corresponding to Exceedance Probability (cfs)			
Subbasin	**90%**	**50%**	**20%**	**10%**
I1	0.10	0.84	3.54	5.64
I2	0.06	0.40	2.25	3.91
I3	0.01	0.07	0.17	0.24
I4	0.08	0.50	2.42	3.94
I5	0.07	0.46	1.86	3.11
I6	0.06	0.39	1.61	2.56
I7	0.06	0.37	1.38	2.19
I3A	0.01	0.04	0.08	0.12
I4A	0.07	0.49	2.36	3.83

Table 6c – Inglewood Basin Flow Duration Analysis Results, Forested Land Use

	Future Land Use Discharge Corresponding to Exceedance Probability (cfs)			
Subbasin	**90%**	**50%**	**20%**	**10%**
I1	0.08	0.58	2.79	4.81
I2	0.05	0.31	1.65	3.28
I3	0.01	0.09	0.21	0.30
I4	0.06	0.37	1.90	3.46
I5	0.05	0.32	1.23	2.09
I6	0.04	0.24	0.68	1.40
I7	0.03	0.22	0.51	1.04
I3A	0.02	0.16	0.37	0.55
I4A	0.05	0.35	1.62	2.89

Table 7a – Thompson Basin Flow Duration Analysis Results, Existing Land Use

	Existing Land Use Discharge Corresponding to Exceedance Probability (cfs)			
Subbasin	**90%**	**50%**	**20%**	**10%**
t1	0.08	0.53	2.48	4.24
t2	0.08	0.50	2.39	4.09
t3	0.07	0.45	2.05	3.52
t4	0.07	0.45	1.91	3.26
t5 Wetland 17	0.07	0.44	1.77	3.01
t8	0.04	0.24	0.60	1.09
t9	0.03	0.17	0.40	0.61
t12 Wetland 61	0.03	0.16	0.38	0.58
t7	0.03	0.21	0.49	0.90
t15	0.03	0.19	0.43	0.77

Table 7b – Thompson Basin Flow Duration Analysis Results, Future Mitigated Land Use

	Future Land Use Discharge Corresponding to Exceedance Probability (cfs)			
Subbasin	**90%**	**50%**	**20%**	**10%**
t1	0.09	0.80	3.29	4.89
t2	0.09	0.79	3.20	4.75
t3	0.09	0.72	2.82	4.17
t4	0.09	0.68	2.58	3.77
t5 Wetland 17	0.08	0.64	2.32	3.38
t8	0.05	0.31	0.80	1.15
t9	0.03	0.18	0.42	0.58
t12 Wetland 61	0.03	0.17	0.40	0.56
t7	0.04	0.27	0.63	0.90
t15	0.03	0.22	0.50	0.66

Table 7c – Thompson Basin Flow Duration Analysis Results, Forested Land Use

	Future Land Use Discharge Corresponding to Exceedance Probability (cfs)			
Subbasin	**90%**	**50%**	**20%**	**10%**
t1	0.05	0.35	1.54	2.75
t2	0.05	0.34	1.47	2.64
t3	0.05	0.30	1.17	2.17
t4	0.04	0.29	1.07	1.95
t5 Wetland 17	0.04	0.29	0.98	1.75
t8	0.02	0.16	0.38	0.59
t9	0.02	0.11	0.25	0.36
t12 Wetland 61	0.02	0.11	0.24	0.35
t7	0.02	0.14	0.33	0.47
t15	0.02	0.12	0.28	0.40

SUMMARY AND RECOMMENDATIONS

A hydrologic analysis of the Inglewood and Thompson Basins was performed using the HSPF and MGSFlood models in support of the Inglewood Basin Plan Update, the Thompson Basin Plan, and the Sammamish Town Center Comprehensive Stormwater Plan. HSPF models developed for earlier analyses were updated to reflect changes in land use and to include additional subbasins in the proposed Town Center development area. The HSPF model was calibrated to streamflow data collected over a 20 month period from October 2001 through May 2003 at the outlet of George Davis Creek (Inglewood Basin). Flow data collected at the mouth of Ebright Creek was not of sufficient quality to use for model calibration; however, comparisons of simulated flows showed a fairly close match with the recorded data for Ebright Creek.

The MGSFlood model uses similar computational algorithms as HSPF, but also includes routines for analyzing stormwater detention and LID mitigation techniques. Watershed input data and runoff parameters used in the HSPF model development and calibration were used to create MGSFlood model input. The MGSFlood model was used to analyze treatment alternatives at Town Center that included detention and LID measures.

The presence of glacial outwash in the central part of the Inglewood Basin infiltrates the majority of surface flow produced in the upper parts of the watershed and results in little or no flow in the stream immediately upstream of the ravine (Subbasin I2). Downstream, the stream intersects the groundwater table (Subbasin I1) and receives the majority of flow via groundwater discharge. The groundwater discharge also produces year around base flow in the lower reaches of the stream. The outwash deposit infiltrates and stores runoff from the upper watershed and is equivalent to approximately 7,000 acre-feet of stormwater detention storage. Flows in the lower stream reach are relatively low (attenuated) during floods because of the storage that occurs in the outwash deposit.

The Thompson Basin does not have the same infiltrative outwash deposit as the Inglewood Basin, but does have a large wetland (Wetland 17) situated at the top of the ravine. This 30 acre wetland provides substantial flood attenuation and buffering of flows entering from the uplands before discharging to the ravine.

Existing and future build-out conditions were simulated with the HSPF model and flood peak and flow duration statistics computed. Little or no increases in runoff rates relative to existing conditions were predicted under future land for the Inglewood Basin. In the Thompson Basin, future peak flow rates were predicted to decrease relative to existing conditions. These results show that stormwater mitigation designed according to the City's stormwater detention standard, which seeks to control runoff rates to forested conditions, is effective at mitigating increased runoff due to development. Because of this, the rates of erosion and flooding should not increase in the future and in areas of the Thompson Basin, may actually decrease provided that the facilities are properly maintained in the future.

RECOMMENDATIONS

1. Maintenance of Outwash Infiltration Areas –The glacial outwash deposit in the central part of the Inglewood Basin is currently infiltrating the majority of surface runoff from the upper watershed. Maintaining the infiltration function of this area is critical to ensuring a stable flow regime and the health of George Davis Creek in the future.

   Infiltration of stormwater with pretreatment should be encouraged for new developments located in areas with outwash deposits. A general map of the geology of the Inglewood Basin showing the extent of the outwash deposit is shown in Figure 4. Local site conditions will dictate whether infiltration is feasible on an individual development site and must be evaluated by the site development engineer. Stormwater conveyance should also be maintained in open channels to the greatest extent possible to promote infiltration into the outwash deposit.

2. On-Site Detention and Low Impact Development Methods – The City's detention standard, which is consistent with the 2005 Ecology Stormwater Management Manual[16], is effective at mitigating the increased potential for flooding and erosion associated with development. Stormwater detention facilities designed according to this standard are large and often expensive to construct. Low Impact Development (LID) methods provide a means to reduce the rate and volume of runoff associated with development, and increases the amount of potential groundwater recharge. LID methods should be encouraged to the greatest extent practical for new construction in the Inglewood and Thompson watersheds.

3. Streamflow Monitoring – Streamflow gages have been operated and maintained by a third party contractor in the past at the mouth of George Davis and Ebright creeks. These gages should be reestablished and data collected from them quality checked and validated on an on-going basis.

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APPENDIX A – LAND USE DATA

Table A-1 – Inglewood Basin Forested Land Use (acres)

Subbasin	Impervious	Till Forest	Till Grass	Outwash Forest	Outwash Grass	Wetland	Total
I1	0.0	81.8	0.0	121.8	0.0	0.0	203.7
I10	0.0	20.5	0.0	3.2	0.0	0.0	23.7
I11	0.0	12.6	0.0	0.2	0.0	0.0	12.8
I12	0.0	13.7	0.0	5.5	0.0	0.0	19.2
I13	0.0	39.2	0.0	1.2	0.0	3.5	43.9
I14	0.0	9.9	0.0	0.0	0.0	1.7	11.7
I2	0.0	188.5	0.0	62.9	0.0	0.0	251.4
I3	0.0	39.4	0.0	12.4	0.0	5.1	56.9
I3A	0.0	4.3	0.0	24.0	0.0	27.0	55.4
I4	0.0	3.1	0.0	10.1	0.0	0.0	13.2
I4A	0.0	164.9	0.0	187.7	0.0	21.9	374.6
I5	0.0	8.3	0.0	48.3	0.0	19.3	76.0
I5A	0.0	49.9	0.0	6.3	0.0	14.6	70.8
I5B	0.0	54.4	0.0	0.0	0.0	0.0	54.4
I6	0.0	42.1	0.0	13.9	0.0	0.0	56.0
I6A	0.0	21.2	0.0	0.1	0.0	0.0	21.3
I7	0.0	216.5	0.0	5.4	0.0	17.5	239.4
I7A	0.0	17.7	0.0	0.3	0.0	0.0	18.0
I8	0.0	11.4	0.0	0.0	0.0	0.0	11.4
I9	0.0	20.8	0.0	3.1	0.0	0.2	24.1
Total	0.0	1020	0.0	506	0.0	111	1637.7

Table A-2 – Inglewood Basin Existing (year 2006) Land Use (acres)

Subbasin	Impervious	Till Forest	Till Grass	Outwash Forest	Outwash Grass	Wetland	Total
I1	20.0	32.5	41.3	43.1	66.8	0.0	203.7
I10	1.3	4.2	15.2	0.0	3.0	0.0	23.7
I11	0.5	7.9	4.2	0.0	0.2	0.0	12.8
I12	0.9	1.7	11.3	3.4	1.8	0.0	19.2
I13	4.5	11.9	22.9	0.0	1.0	3.5	43.9
I14	0.1	8.4	1.4	0.0	0.0	1.7	11.7
I2	27.7	63.0	104.7	12.0	44.0	0.0	251.4
I3	5.7	2.1	33.0	1.4	9.6	5.1	56.9
I3A	3.5	1.0	2.9	0.0	21.0	27.0	55.4
I4	0.8	2.9	0.0	0.6	8.9	0.0	13.2
I4A	102.9	28.7	88.1	36.9	96.1	21.9	374.6
I5	25.5	2.1	2.5	7.0	19.6	19.3	76.0
I5A	1.0	27.5	21.5	3.2	3.0	14.6	70.8
I5B	10.7	5.1	38.6	0.0	0.0	0.0	54.4
I6	2.3	13.7	26.7	2.9	10.4	0.0	56.0
I6A	4.9	0.0	16.3	0.0	0.1	0.0	21.3
I7	31.5	77.9	107.9	4.6	0.0	17.5	239.4
I7A	4.0	0.4	13.3	0.0	0.2	0.0	18.0
I8	0.5	3.5	7.4	0.0	0.0	0.0	11.4
I9	2.1	11.5	7.5	0.0	2.8	0.2	24.1
Total	251	306	567	115	289	111	1637.7

Table A-3 – Inglewood Basin Future Build-Out Land Use, According to City of Sammamish Zoning and Sammamish Town Center Plan (acres)

Subbasin	Impervious	Till Forest	Till Grass	Outwash Forest	Outwash Grass	Wetland	Total
I1	58.3	0.0	59.5	0.0	85.9	0.0	203.7
I10	4.5	0.0	16.8	0.0	2.4	0.0	23.7
I11	6.7	0.0	6.1	0.0	0.1	0.0	12.8
I12	8.7	0.0	6.0	0.0	3.4	1.0	19.2
I13	15.4	0.0	24.9	0.0	0.2	3.5	43.9
I14	2.7	0.0	7.0	0.0	0.0	1.9	11.7
I2	74.5	0.0	130.3	0.0	46.6	0.0	251.4
I3	12.6	0.0	26.2	0.0	9.0	9.0	56.9
I3A	4.5	0.0	0.3	0.0	11.1	39.5	55.4
I4	3.5	0.0	2.2	0.0	7.5	0.0	13.2
I4A	168.2	0.0	92.7	0.0	98.2	15.5	374.6
I5	30.0	0.0	5.5	0.0	10.8	29.6	76.0
I5A	11.6	0.0	41.0	0.0	5.3	12.9	70.8
I5B	17.3	0.0	35.7	0.0	0.0	1.4	54.4
I6	12.0	0.0	32.8	0.0	10.9	0.2	56.0
I6A	7.9	0.0	13.3	0.0	0.0	0.0	21.3
I7	63.9	0.0	153.8	0.0	3.8	17.8	239.4
I7A	5.4	0.0	11.8	0.0	0.2	0.7	18.0
I8	5.2	0.0	6.2	0.0	0.0	0.0	11.4
I9	10.8	0.0	11.8	0.0	1.5	0.0	24.1
Total	524	0	684	0	297	133	1637.7

Table A-4 – Thompson Basin Forested Land Use (acres)

Subbasin	Impervious	Till Forest	Till Grass	Outwash Forest	Outwash Grass	Wetland	Total
t01	0.0	15.2	0.0	1.0	0.0	0.0	16.2
t02	0.0	66.4	0.0	1.6	0.0	0.0	68.0
t03	0.0	45.8	0.0	3.3	0.0	3.3	52.4
t04	0.0	44.5	0.0	1.5	0.0	0.0	46.0
t05	0.0	85.9	0.0	48.1	0.0	28.3	162.3
t06	0.0	26.0	0.0	51.9	0.0	3.8	81.7
t07	0.0	23.5	0.0	33.6	0.0	7.7	64.7
t08	0.0	65.2	0.0	43.8	0.0	0.0	109.0
t09	0.0	4.0	0.0	7.3	0.0	0.0	11.3
t10	0.0	23.2	0.0	0.1	0.0	0.0	23.3
t11	0.0	5.4	0.0	4.2	0.0	0.4	10.0
t12	0.0	0.4	0.0	0.3	0.0	5.7	6.4
t13	0.0	16.8	0.0	4.4	0.0	0.0	21.2
t14	0.0	18.5	0.0	12.0	0.0	0.0	30.5
t15	0.0	5.9	0.0	24.6	0.0	0.0	30.5
t16	0.0	27.5	0.0	0.0	0.0	0.0	27.5
t17	0.0	36.9	0.0	0.2	0.0	0.0	37.1
Total	0.0	511.1	0.0	237.7	0.0	49.2	798.0

Table A-5 – Thompson Basin Existing Land Use (acres)

Subbasin	Impervious	Till Forest	Till Grass	Outwash Forest	Outwash Grass	Wetland	Total
t01	1.0	2.8	11.5	0.0	0.9	0.0	16.2
t02	2.5	32.6	31.5	1.2	0.3	0.0	68.0
t03	1.0	30.8	14.1	3.2	0.0	3.3	52.4
t04	1.6	24.0	19.0	0.0	1.5	0.0	46.0
t05	7.7	19.8	61.1	16.5	28.8	28.3	162.3
t06	5.7	5.6	18.5	25.0	23.1	3.8	81.7
t07	2.5	14.8	7.7	15.3	16.8	7.7	64.7
t08	5.6	26.0	35.9	11.1	30.4	0.0	109.0
t09	0.7	0.0	3.7	3.5	3.3	0.0	11.3
t10	2.3	0.0	20.9	0.0	0.1	0.0	23.3
t11	0.2	0.2	5.0	0.1	4.0	0.4	10.0
t12	0.0	0.1	0.3	0.2	0.1	5.7	6.4
t13	0.3	0.5	16.1	0.6	3.7	0.0	21.2
t14	11.4	3.6	8.0	1.2	6.3	0.0	30.5
t15	1.4	2.7	3.0	14.3	9.1	0.0	30.5
t16	9.3	0.5	17.6	0.0	0.0	0.0	27.5
t17	10.4	1.3	25.3	0.0	0.1	0.0	37.1
Total	63.5	165.2	299.2	92.3	128.7	49.2	798.0

Table A-6 – Thompson Basin Future Build-Out Land Use, According to City of Sammamish Zoning and Sammamish Town Center Plan (acres)

Subbasin	Impervious	Till Forest	Till Grass	Outwash Forest	Outwash Grass	Wetland	Total
t01	2.4	0.0	12.9	0.0	0.9	0.0	16.2
t02	11.0	0.0	55.6	0.0	1.4	0.0	68.0
t03	5.2	0.0	41.0	0.0	2.9	3.3	52.4
t04	7.6	0.0	37.5	0.0	1.0	0.0	46.0
t05	30.6	0.0	63.5	0.0	39.8	28.3	162.3
t06	18.2	0.0	21.2	0.0	38.6	3.8	81.7
t07	11.2	0.0	19.6	0.0	26.3	7.7	64.7
t08	24.2	0.0	49.5	0.0	35.2	0.0	109.0
t09	1.8	0.0	3.2	0.0	6.3	0.0	11.3
t10	7.8	0.0	15.4	0.0	0.1	0.0	23.3
t11	0.1	0.0	5.4	0.0	4.1	0.4	10.0
t12	0.1	0.0	0.4	0.0	0.3	5.6	6.4
t13	7.0	0.0	10.0	0.0	4.2	0.0	21.2
t14	15.5	0.0	8.5	0.0	6.4	0.0	30.5
t15	7.2	0.0	4.5	0.0	18.8	0.0	30.5
t16	13.3	0.0	14.2	0.0	0.0	0.0	27.5
t17	14.4	0.0	22.6	0.0	0.1	0.0	37.1
Total	177.4	0.0	384.9	0.0	186.6	49.2	798.0

APPENDIX B

Wetland Data Forms

Sammamish Basin Plans
Wetland Field Data Form

W of Inglewood Hill Rd.

Wetland No: 14B. **Location:** behind Presbyterian Church. **Date:** Dec 4/08

Sub-basin: Inglewood **Cowardin Class:** PEM **HGM Class:** depressional.

Estimated Wetland Size (ac): <0.1 ___ 0.1-1 ✓ 1-5 ___ 5-10 ___ >10 ___

Identified by: CH, EC **Photo No.** ___

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes ☐ No ☑

- ☐ a. dredging
- ☐ b. filling
- ☐ c. draining
- ☐ d. clearing
- ☐ e. drainage ditches/diversions
- ☐ f. crop production
- ☐ g. other ___

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes ☑ No ☐

- ☐ a. clearing
- ☐ b. grazing/agriculture
- ☐ c. litter
- ☐ d. recreational overuse
- ☑ e. residential development
- ☐ f. other ___

Hydrology

Water sources and hydroperiod:

- ☐ Ground water (perched water table, through flow…)
- ☐ Surface water
- ☑ Seep
- ☐ Seasonally flooded/saturated
- ☐ Permanently flooded/saturated
- ☐ Other ___

Inlet/outlet:

- ☑ a. constrained, size ___
- ☐ b. unconstrained
- ☐ c. natural channel
- ☑ d. none runoff
- ☑ e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes ☐ No ☑

Indicators of wetland hydrology:

- ☐ a. inundation
- ☑ b. saturated in upper 12"
- ☐ c. water marks
- ☐ d. drift lines
- ☐ e. sediment deposits
- ☐ f. drainage patterns in wetlands
- ☐ h. water-stained leaves
- ☐ i. other ___

Soil

Is the wetland mapped on hydric soil? Yes ☐ No ☐

Soil profile: –

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: PHAR, RUSP

Invasive Species? Yes (%) 90 No

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1	✓	2		≥3	
Degree of interspersion:	Low	✓	Mod		High	

Vegetation connectivity to other habitats? no

Food sources or habitat features for wildlife? no

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [ ] a. grass-lawn
- [ ] b. herbaceous-native
- [ ] c. scrub-shrub
- [✓] d. forested
- [ ] f. other ______

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [ ] b. % <25 ft
- [50] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [✓] a. restoration
- [ ] b. creation
- [✓] c. enhancement
- [ ] d. preservation

Notes:

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 18 **Observer(s):** CH, EC. **Date:** Dec 4/08

FUNCTION	LOW RATING	MODERATE RATING	HIGH RATING
Water Quality Improvement	rapid flow through wetland	moderate flow through wetland	✓ little or no flow present
	<50% vegetation density	50-80% vegetation density	✓ >80% vegetation density
	no proximity to pollutants	✓ downstream from non-point pollutants	downstream from point discharges
Evaluation:	✓ detains <25% overland runoff	detains 25-50% overland runoff	detains >50% overland runoff
Flood/Storm Water Control	✓ size <5 acres	size 5-10 acres	size >10 acres
Evaluation:	✓ riverine, shallow depression (circled)	mid-sloped wetland	lake, depressions, headwaters, bogs
Groundwater Recharge	✓ size <5 acres	size 5-10 acres	size >10 acres
	temporarily saturated/inundated	✓ seasonally saturated/inundated	permanently inundated
Evaluation:	springs present outflow>inflow	✓ outflow=inflow	outflow<inflow
Natural Biological Support	✓ size <5 acres	size 5-10 acres	size >10 acres
	✓ isolated systems associated with ephemeral surface water	associated with permanent surface water	associated with permanent open water
	✓ one habitat type	two habitat types	three or more habitat types
	✓ little or no interspersion of habitats	some habitat interspersion	habitats highly interspersed
	✓ low plant diversity	moderate plant diversity	high plant diversity
	✓ few, if any habitat features present	some habitat features present	several habitat features present
	adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	buffers generally undisturbed native vegetation and undeveloped
	✓ few connections to other habitat types	some connection to other habitat types	significant connections to high quality habitat types
Evaluation:	✓ Agricultural land or low vegetation structure	moderate vegetation structure	high vegetation structure
Erosion/Shoreline Protection	✓ sparse grass/forbs or not vegetation	sparse woody vegetation or dense herb vegetation	dense woody vegetation
Evaluation:			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: 18 Location: E of 228th 3 bisected by SE 8th Date: Dec 4/08

Sub-basin: Inglewood Cowardin Class: PSS, PFO, PEM HGM Class: Riverine

Estimated Wetland Size (ac): <0.1 ___ 0.1-1 ___ 1-5 ___ 5-10 ___ >10 X

Identified by: CH, EC Photo No. ___

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes [ ] No [X]

- [ ] a. dredging
- [ ] b. filling
- [ ] c. draining
- [ ] d. clearing
- [ ] e. drainage ditches/diversions
- [ ] f. crop production
- [ ] g. other ___

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes [ ] No [ ]

- [ ] a. clearing
- [ ] b. grazing/agriculture
- [ ] c. litter
- [ ] d. recreational overuse
- [X] e. residential development
- [ ] f. other ___

Hydrology

Water sources and hydroperiod:

- [ ] Ground water (perched water table, through flow…)
- [✓] Surface water
- [ ] Seep
- [ ] Seasonally flooded/saturated
- [ ] Permanently flooded/saturated
- [ ] Other ___

Inlet/outlet:

- [ ] a. constrained, size___
- [✓] b. unconstrained
- [✓] c. natural channel
- [ ] d. none
- [ ] e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes [✓] No [ ]

Indicators of wetland hydrology:

- [ ] a. inundation
- [ ] b. saturated in upper 12"
- [ ] c. water marks
- [ ] d. drift lines
- [ ] e. sediment deposits
- [ ] f. drainage patterns in wetlands
- [ ] h. water-stained leaves
- [ ] i. other ___

Soil

Is the wetland mapped on hydric soil? Yes [ ] No [ ]

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: Salix, ALRU, QUAR, ~~THMA~~ RUSP, SEPO, COSE

Invasive Species? Yes (%) ✓ No ___

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1		2		≥3	✓
Degree of interspersion:	Low		Mod		High	✓

Vegetation connectivity to other habitats? yes

Food sources or habitat features for wildlife? yes, – snags

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes ☐ No ☐

- ☐ a. grass-lawn
- ☐ b. herbaceous-native
- ☐ c. scrub-shrub
- ☐ d. forested
- ☐ f. other ___

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- ☐ a. % no buffer
- ☐ b. % <25 ft
- 70 c. % 25-50 ft
- ☐ d. % 50-100 ft
- ☐ e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes ✓ No ☐

- ✓ a. restoration
- ☐ b. creation
- ✓ c. enhancement
- ☐ d. preservation

Notes: remove lawn grass that abuts wetland, artificial ponds created could remove (N of 8th off of 234th Ave SE

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 18 **Observer(s):** CH, EC **Date:** Dec. 4/08

FUNCTION	CRITERIA: LOW RATING	CRITERIA: MODERATE RATING	CRITERIA: HIGH RATING
Water Quality Improvement	___ rapid flow through wetland	✓ moderate flow through wetland	___ little or no flow present
	___ <50% vegetation density	___ 50-80% vegetation density	✓ >80% vegetation density
	___ no proximity to pollutants	✓ downstream from non-point pollutants	___ downstream from point discharges
Evaluation:	___ detains <25% overland runoff	___ detains 25-50% overland runoff	✓ detains >50% overland runoff
Flood/Storm Water Control	___ size <5 acres	___ size 5-10 acres	✓ size >10 acres
Evaluation:	✓ riverine (circled), shallow depression	___ mid-sloped wetland	✓ lake, depressions, ~~headwaters~~, bogs (circled)
Groundwater Recharge	___ size <5 acres	___ size 5-10 acres	✓ size >10 acres
	___ temporarily saturated/inundated	✓ seasonally saturated/inundated	✓ permanently inundated
Evaluation:	___ springs present outflow>inflow	✓ outflow=inflow	___ outflow<inflow
Natural Biological Support	___ size <5 acres	___ size 5-10 acres	✓ size >10 acres
	___ isolated systems associated with ephemeral surface water	✓ associated with permanent surface water	___ associated with permanent open water
	___ one habitat type	___ two habitat types	✓ three or more habitat types
	___ little or no interspersion of habitats	___ some habitat interspersion	✓ habitats highly interspersed
	___ low plant diversity	___ moderate plant diversity	✓ high plant diversity
	___ few, if any habitat features present	___ some habitat features present	✓ several habitat features present
	___ adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	___ buffers generally undisturbed native vegetation and undeveloped
	___ few connections to other habitat types	✓ some connection to other habitat types	___ significant connections to high quality habitat types
Evaluation:	___ Agricultural land or low vegetation structure	___ moderate vegetation structure	✓ high vegetation structure
Erosion/Shoreline Protection	___ sparse grass/forbs or not vegetation	___ sparse woody vegetation or dense herb vegetation	✓ dense woody vegetation
Evaluation:			

Sammamish Basin Plans
Wetland Field Data Form

1832

Wetland No:	WK8	Location:	235th Ave. NE. N of NE 8th	Date:	Dec 4/08
Sub-basin:	Inglewood.	Cowardin Class:	PEm, open water	HGM Class:	Dep.

Estimated Wetland Size (ac): <0.1 ___ 0.1-1 ___ 1-5 ✓ 5-10 ___ >10 ___

Identified by: CH, EC. Photo No. ___

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes ☐ No ☐

- ☐ a. dredging
- ☐ b. filling
- ☐ c. draining
- ☐ d. clearing
- ☐ e. drainage ditches/diversions
- ☐ f. crop production
- ☐ g. other ___

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes ☑ No ☐

- ☐ a. clearing
- ☐ b. grazing/agriculture
- ☐ c. litter
- ☐ d. recreational overuse
- ☑ e. residential development
- ☐ f. other ___

Hydrology

Water sources and hydroperiod:

- ☑ Ground water (perched water table, through flow…)
- ☐ Surface water
- ☐ Seep
- ☑ Seasonally flooded/saturated
- ☐ Permanently flooded/saturated
- ☐ Other ponding

Inlet/outlet:

- ☐ a. constrained, size ___
- ☐ b. unconstrained
- ☐ c. natural channel
- ☑ d. none
- ☑ e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes ☐ No ☑

Indicators of wetland hydrology:

- ☑ a. inundation
- ☑ b. saturated in upper 12"
- ☐ c. water marks
- ☐ d. drift lines
- ☐ e. sediment deposits
- ☐ f. drainage patterns in wetlands
- ☐ h. water-stained leaves
- ☐ i. other ___

Soil

Is the wetland mapped on hydric soil? Yes ☐ No ☐

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: Poa, Salix sp. PHAR, SPDO

Invasive Species? Yes (%) 20 No ___

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1	✓	2		≥ 3	
Degree of interspersion:	Low	✓	Mod		High	

Vegetation connectivity to other habitats? no

Food sources or habitat features for wildlife? no

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [✓] a. grass-lawn
- [ ] b. herbaceous-native
- [ ] c. scrub-shrub
- [✓] d. forested
- [ ] f. other ______

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [65] b. % <25 ft
- [ ] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [ ] No [ ]

- [✓] a. restoration
- [ ] b. creation
- [ ] c. enhancement
- [ ] d. preservation

Notes:

Shelly 425-894-7704
Mike 425-444-0903

1832

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. W15 **Observer(s):** CH, EC **Date:** Dec 4/08

FUNCTION	CRITERIA: LOW RATING	MODERATE RATING	HIGH RATING
Water Quality Improvement	rapid flow through wetland	moderate flow through wetland	✓ little or no flow present
	<50% vegetation density	50-80% vegetation density	✓ >80% vegetation density
	no proximity to pollutants	✓ downstream from non-point pollutants	downstream from point discharges
Evaluation:	✓ detains <25% overland runoff	detains 25-50% overland runoff	detains >50% overland runoff
Flood/Storm Water Control	size <5 acres	✓ size 5-10 acres	size >10 acres
Evaluation:	riverine, shallow depression	mid-sloped wetland	lake, depressions (circled), headwaters, bogs
Groundwater Recharge	✓ size <5 acres	size 5-10 acres	size >10 acres
	temporarily saturated/inundated	✓ seasonally saturated/inundated	permanently inundated
Evaluation:	springs present outflow>inflow	✓ outflow=inflow	outflow<inflow
Natural Biological Support	✓ size <5 acres	size 5-10 acres	size >10 acres
	✓ isolated systems associated with ephemeral surface water	associated with permanent surface water	associated with permanent open water
	✓ one habitat type	two habitat types	three or more habitat types
	✓ little or no interspersion of habitats	some habitat interspersion	habitats highly interspersed
	✓ low plant diversity	moderate plant diversity	high plant diversity
	✓ few, if any habitat features present	some habitat features present	several habitat features present
	adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	buffers generally undisturbed native vegetation and undeveloped
	✓ few connections to other habitat types	some connection to other habitat types	significant connections to high quality habitat types
Evaluation:	Agricultural land or low vegetation structure	✓ moderate vegetation structure	high vegetation structure
Erosion/Shoreline Protection	sparse grass/forbs or not vegetation	✓ sparse woody vegetation or dense herb vegetation	dense woody vegetation
Evaluation:			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: ~~Pb~~ 1502 Location: N of NE 8th Date: Dec 4/08

Sub-basin: Inglewood Cowardin Class: PSS, PEM HGM Class: Dep

Estimated Wetland Size (ac): <0.1 ____ 0.1-1 ✓ 1-5 ____ 5-10 ____ >10 ____

Identified by: CH, EC Photo No. ____

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes [ ] No [✓]

- [ ] a. dredging
- [ ] b. filling
- [ ] c. draining
- [ ] d. clearing
- [ ] e. drainage ditches/diversions
- [ ] f. crop production
- [ ] g. other ____

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes [✓] No [ ]

- [ ] a. clearing
- [ ] b. grazing/agriculture
- [ ] c. litter
- [ ] d. recreational overuse
- [X] e. residential development
- [ ] f. other ____

Hydrology

Water sources and hydroperiod:

- [X] Ground water (perched water table, through flow…)
- [ ] Surface water
- [ ] Seep
- [ ] Seasonally flooded/saturated
- [ ] Permanently flooded/saturated
- [ ] Other ____

Inlet/outlet:

- [ ] a. constrained, size____
- [ ] b. unconstrained
- [ ] c. natural channel
- [ ] d. none
- [✓] e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes [ ] No [✓]

Indicators of wetland hydrology:

- [ ] a. inundation
- [✓] b. saturated in upper 12"
- [ ] c. water marks
- [ ] d. drift lines
- [ ] e. sediment deposits
- [ ] f. drainage patterns in wetlands
- [ ] h. water-stained leaves
- [ ] i. other ____

Soil

Is the wetland mapped on hydric soil? Yes [ ] No [ ]

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: ____ Invasive Species? Yes (%) 20 ____ No ____

RUSP, SPDO, ALRU, Salix, RULA, THPL, PHAR

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1		2	✓	≥3	
Degree of interspersion:	Low	✓	Mod		High	
Vegetation connectivity to other habitats?						
Food sources or habitat features for wildlife?						

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [✓] a. grass-lawn
- [ ] b. herbaceous-native
- [ ] c. scrub-shrub
- [✓] d. forested
- [ ] f. other ____

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [ ] b. % <25 ft
- [80] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [✓] a. restoration
- [ ] b. creation
- [ ] c. enhancement
- [ ] d. preservation

Notes:

WQ	H	BioSupport L
	H	L
	M	M
	L	L
Flood/S10	L	L
	$ (shallow dep)	M
GW. recharge	L	M
	M	M
	M	M
		H

Data transferred to → data sheet. Dec 8/08

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 1502 **Observer(s):** Ncl NE 8th **Date:** Dec 4/08

FUNCTION	CRITERIA: LOW RATING	MODERATE RATING	HIGH RATING
Water Quality Improvement	___ rapid flow through wetland	___ moderate flow through wetland	✓ little or no flow present
	___ <50% vegetation density	___ 50-80% vegetation density	✓ >80% vegetation density
	___ no proximity to pollutants	✓ downstream from non-point pollutants	___ downstream from point discharges
Evaluation: ___	✓ detains <25% overland runoff	___ detains 25-50% overland runoff	___ detains >50% overland runoff
Flood/Storm Water Control	✓ size <5 acres	___ size 5-10 acres	___ size >10 acres
Evaluation: ___	✓ riverine, shallow depression	___ mid-sloped wetland	___ lake, depressions, headwaters, bogs
Groundwater Recharge	✓ size <5 acres	___ size 5-10 acres	___ size >10 acres
	___ temporarily saturated/inundated	✓ seasonally saturated/inundated	___ permanently inundated
Evaluation: ___	___ springs present outflow>inflow	✓ outflow=inflow	___ outflow<inflow
Natural Biological Support	✓ size <5 acres	___ size 5-10 acres	___ size >10 acres
	✓ isolated systems associated with ephemeral surface water	___ associated with permanent surface water	___ associated with permanent open water
	___ one habitat type	✓ two habitat types	___ three or more habitat types
	✓ little or no interspersion of habitats	___ some habitat interspersion	___ habitats highly interspersed
	✓ low plant diversity	___ moderate plant diversity	___ high plant diversity
	___ few, if any habitat features present	✓ some habitat features present	___ several habitat features present
	___ adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	___ buffers generally undisturbed native vegetation and undeveloped
	___ few connections to other habitat types	✓ some connection to other habitat types	___ significant connections to high quality habitat types
Evaluation: ___	___ Agricultural land or low vegetation structure	✓ moderate vegetation structure	___ high vegetation structure
Erosion/Shoreline Protection	___ sparse grass/forbs or not vegetation	___ sparse woody vegetation or dense herb vegetation	✓ dense woody vegetation
Evaluation: ___			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: 1509 **Location:** Starts E of 228th Ave goes to 244th **Date:** Dec 4/08

Sub-basin: Inglewood **Cowardin Class:** PSS, PEM, **HGM Class:** Riverine

Estimated Wetland Size (ac): <0.1 ___ 0.1-1 ___ 1-5 ___ 5-10 ___ >10 ✓

Identified by: CH, EC **Photo No.** ___

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes ☐ No ☑

- ☐ a. dredging
- ☐ b. filling
- ☐ c. draining
- ☐ d. clearing
- ☐ e. drainage ditches/diversions
- ☐ f. crop production
- ☐ g. other development, pipeline

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes ☑ No ☐

- ☐ a. clearing
- ☐ b. grazing/agriculture
- ☐ c. litter
- ☐ d. recreational overuse
- ☒ e. residential development
- ☐ f. other ___

Hydrology

Water sources and hydroperiod:

- ☐ Ground water (perched water table, through flow…)
- ☑ Surface water
- ☐ Seep
- ☑ Seasonally flooded/saturated
- ☑ Permanently flooded/saturated
- ☐ Other ___

Inlet/outlet:

- ☐ a. constrained, size___
- ☐ b. unconstrained
- ☐ c. natural channel
- ☐ d. none
- ☑ e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes ☑ No ☐

Indicators of wetland hydrology:

- ☑ a. inundation
- ☑ b. saturated in upper 12"
- ☐ c. water marks
- ☐ d. drift lines
- ☐ e. sediment deposits
- ☐ f. drainage patterns in wetlands
- ☐ h. water-stained leaves
- ☐ i. other ___

Soil

Is the wetland mapped on hydric soil? Yes ☐ No ☐

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: Invasive Species? Yes (%) 20+ No ___

RUSP, ~~bke~~ PHCA, POBA, red osier, TYLA, ELAR

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1		2		≥ 3	✓
Degree of interspersion:	Low		Mod		High	✓

Vegetation connectivity to other habitats? yes.

Food sources or habitat features for wildlife? ~~tbop~~, snags.

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [X] a. grass-lawn
- [ ] b. herbaceous-native
- [ ] c. scrub-shrub
- [X] d. forested
- [X] f. other large wetland, buffer developed

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [100] b. % <25 ft
- [ ] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [ ] a. restoration
- [ ] b. creation
- [✓] c. enhancement
- [ ] d. preservation

Notes:

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 1509 Observer(s): CH, EC Date: Dec 4/00

FUNCTION	LOW RATING	MODERATE RATING	HIGH RATING
Water Quality Improvement	rapid flow through wetland	✓ moderate flow through wetland	little or no flow present
	<50% vegetation density	50-80% vegetation density	✓ >80% vegetation density
	no proximity to pollutants	✓ downstream from non-point pollutants	downstream from point discharges
Evaluation:	detains <25% overland runoff	detains 25-50% overland runoff	✓ detains >50% overland runoff
Flood/Storm Water Control	size <5 acres	size 5-10 acres	✓ size >10 acres
Evaluation:	(riverine, circled) shallow depression	mid-sloped wetland	lake, depressions, headwaters, bogs
Groundwater Recharge	size <5 acres	size 5-10 acres	✓ size >10 acres
	temporarily saturated/inundated	seasonally saturated/inundated	✓ permanently inundated
Evaluation:	springs present outflow>inflow	outflow=inflow	outflow<inflow
Natural Biological Support	size <5 acres	size 5-10 acres	✓ size >10 acres
	isolated systems associated with ephemeral surface water	✓ associated with permanent surface water	associated with permanent open water
	one habitat type	two habitat types	✓ three or more habitat types
	little or no interspersion of habitats	some habitat interspersion	✓ habitats highly interspersed
	low plant diversity	moderate plant diversity	✓ high plant diversity
	few, if any habitat features present	some habitat features present	✓ several habitat features present
	adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	buffers generally undisturbed native vegetation and undeveloped
	few connections to other habitat types	✓ some connection to other habitat types	significant connections to high quality habitat types
Evaluation:	Agricultural land or low vegetation structure	✓ moderate vegetation structure	high vegetation structure
Erosion/Shoreline Protection	sparse grass/forbs or not vegetation	sparse woody vegetation or dense herb vegetation	✓ dense woody vegetation
Evaluation:			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: 1S11 **Location:** E of 228th, N of SE 8th **Date:** Dec 4/08

Sub-basin: Inglewood. **Cowardin Class:** PSS, PEM **HGM Class:** Riverine

Estimated Wetland Size (ac): <0.1 ___ 0.1-1 ___ 1-5 ___ 5-10 ✓ >10 ___

Identified by: CH, CE **Photo No.** ___

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes [ ] No [✓]

- [ ] a. dredging
- [ ] b. filling
- [ ] c. draining
- [ ] d. clearing
- [ ] e. drainage ditches/diversions
- [ ] f. crop production
- [ ] g. other ___

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes [✓] No [ ]

- [ ] a. clearing
- [ ] b. grazing/agriculture
- [ ] c. litter
- [ ] d. recreational overuse
- [✓] e. residential development
- [ ] f. other ___

Hydrology

Water sources and hydroperiod:

- [ ] Ground water (perched water table, through flow…)
- [✓] Surface water
- [ ] Seep
- [ ] Seasonally flooded/saturated
- [ ] Permanently flooded/saturated
- [ ] Other ___

Inlet/outlet:

- [ ] a. constrained, size ___
- [ ] b. unconstrained
- [✓] c. natural channel
- [ ] d. none
- [ ] e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes [✓] No [ ]

Indicators of wetland hydrology:

- [✓] a. inundation
- [ ] b. saturated in upper 12"
- [ ] c. water marks
- [ ] d. drift lines
- [ ] e. sediment deposits
- [ ] f. drainage patterns in wetlands
- [ ] h. water-stained leaves
- [ ] i. other ___

Soil

Is the wetland mapped on hydric soil? Yes [ ] No [ ]

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: Invasive Species? Yes (%) ✓ No ___

JUNCUS sp, TYLA, grass spp, RUSP, RUAR

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1		2		≥3	✓
Degree of interspersion:	Low		Mod		High	✓

Vegetation connectivity to other habitats? yes.

Food sources or habitat features for wildlife? yes

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [✓] a. grass-lawn
- [✓] b. herbaceous-native
- [ ] c. scrub-shrub
- [✓] d. forested
- [ ] f. other ______

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [ ] b. % <25 ft
- [ ] c. % 25-50 ft
- [50] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [✓] a. restoration
- [ ] b. creation
- [ ] c. enhancement
- [ ] d. preservation

Notes:

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 1511 **Observer(s):** CH, FC **Date:** Dec 4/08

FUNCTION	CRITERIA: LOW RATING	MODERATE RATING	HIGH RATING
Water Quality Improvement	___ rapid flow through wetland	✓ moderate flow through wetland	___ little or no flow present
	___ <50% vegetation density	___ 50-80% vegetation density	✓ >80% vegetation density
	___ no proximity to pollutants	✓ downstream from non-point pollutants	___ downstream from point discharges
Evaluation: ___	___ details <25% overland runoff	✓ detains 25-50% overland runoff	___ detains >50% overland runoff
Flood/Storm Water Control	___ size <5 acres	✓ size 5-10 acres	___ size >10 acres
Evaluation: ___	___ (riverine), shallow depression	___ mid-sloped wetland	___ lake, depressions, headwaters, bogs
Groundwater Recharge	___ size <5 acres	✓ size 5-10 acres	___ size >10 acres
	___ temporarily saturated/inundated	___ seasonally saturated/inundated	___ permanently inundated
Evaluation: ___	___ springs present outflow>inflow	___ outflow=inflow	___ outflow<inflow
Natural Biological Support	___ size <5 acres	✓ size 5-10 acres	___ size >10 acres
	___ isolated systems associated with ephemeral surface water	✓ associated with permanent surface water	___ associated with permanent open water
	___ one habitat type	___ two habitat types	✓ three or more habitat types
	___ little or no interspersion of habitats	___ some habitat interspersion	✓ habitats highly interspersed
	___ low plant diversity	✓ moderate plant diversity	___ high plant diversity
	___ few, if any habitat features present	✓ some habitat features present	___ several habitat features present
	___ adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	___ buffers generally undisturbed native vegetation and undeveloped
	___ few connections to other habitat types	___ some connection to other habitat types	✓ significant connections to high quality habitat types
Evaluation: ___	___ Agricultural land or low vegetation structure	___ moderate vegetation structure	✓ high vegetation structure
Erosion/Shoreline Protection	___ sparse grass/forbs or not vegetation	___ sparse woody vegetation or dense herb vegetation	✓ dense woody vegetation
Evaluation: ___			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: 1559 Location: [illegible] S of NE 8th Date: Dec 4/08

Sub-basin: Inglewood Cowardin Class: PSS HGM Class: [illegible] SS

Estimated Wetland Size (ac): <0.1 ___ 0.1-1 ___ 1-5 ✓ 5-10 ___ >10 ___

Identified by: CHCE Photo No. ___

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes [ ] No [X]

- [ ] a. dredging
- [ ] b. filling
- [ ] c. draining
- [ ] d. clearing
- [ ] e. drainage ditches/diversions
- [ ] f. crop production
- [ ] g. other ___

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes [✓] No [ ]

- [ ] a. clearing
- [ ] b. grazing/agriculture
- [ ] c. litter
- [ ] d. recreational overuse
- [X] e. residential development
- [ ] f. other ___

Hydrology

Water sources and hydroperiod:

- [ ] Ground water (perched water table, through flow…)
- [ ] Surface water
- [X] Seep
- [X] Seasonally flooded/saturated
- [ ] Permanently flooded/saturated
- [ ] Other ___

Inlet/outlet:

- [ ] a. constrained, size___
- [ ] b. unconstrained
- [ ] c. natural channel
- [ ] d. none
- [X] e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes [ ] No [ ]

Indicators of wetland hydrology:

- [ ] a. inundation
- [ ] b. saturated in upper 12"
- [ ] c. water marks
- [ ] d. drift lines
- [ ] e. sediment deposits
- [ ] f. drainage patterns in wetlands
- [ ] h. water-stained leaves
- [ ] i. other ___

Soil

Is the wetland mapped on hydric soil? Yes [ ] No [ ]

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: Invasive Species? Yes (%) 40 No ___

ALRU, THPL, Salix sp., SPDO, RUAR

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1	✓	2		≥ 3	
Degree of interspersion:	Low	✓	Mod		High	

Vegetation connectivity to other habitats? no

Food sources or habitat features for wildlife? none

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [X] a. grass-lawn
- [ ] b. herbaceous-native
- [ ] c. scrub-shrub
- [X] d. forested
- [ ] f. other ______

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [ ] b. % <25 ft
- [50] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [X] a. restoration
- [ ] b. creation
- [ ] c. enhancement
- [X] d. preservation

Notes:

233rd Ave goes through WL.

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 1559 Observer(s): CH, EC Date: Dec 4/08

FUNCTION	CRITERIA: LOW RATING	CRITERIA: MODERATE RATING	CRITERIA: HIGH RATING
Water Quality Improvement	rapid flow through wetland	moderate flow through wetland	✓ little or no flow present
	<50% vegetation density	50-80% vegetation density	✓ >80% vegetation density
	no proximity to pollutants	✓ downstream from non-point pollutants	downstream from point discharges
Evaluation:	✓ detains <25% overland runoff	detains 25-50% overland runoff	detains >50% overland runoff
Flood/Storm Water Control	✓ size <5 acres	size 5-10 acres	size >10 acres
Evaluation:	✓ riverine, shallow depression (circled: shallow depression)	mid-sloped wetland	lake, depressions, headwaters, bogs
Groundwater Recharge	✓ size <5 acres	size 5-10 acres	size >10 acres
	✓ temporarily saturated/inundated	seasonally saturated/inundated	permanently inundated
Evaluation:	springs present outflow>inflow	✓ outflow=inflow	outflow<inflow
? **Natural Biological Support**	size <5 acres	size 5-10 acres	size >10 acres
	✓ isolated systems associated with ephemeral surface water	associated with permanent surface water	associated with permanent open water
	✓ one habitat type	two habitat types	three or more habitat types
	✓ little or no interspersion of habitats	some habitat interspersion	habitats highly interspersed
	✓ low plant diversity	moderate plant diversity	high plant diversity
	✓ few, if any habitat features present	some habitat features present	several habitat features present
	adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	buffers generally undisturbed native vegetation and undeveloped
	✓ few connections to other habitat types	some connection to other habitat types	significant connections to high quality habitat types
Evaluation:	Agricultural land or low vegetation structure	✓ moderate vegetation structure	high vegetation structure
Erosion/Shoreline Protection	sparse grass/forbs or not vegetation	sparse woody vegetation or dense herb vegetation	✓ dense woody vegetation
Evaluation:			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: 1577 **Location:** east of 228 **Date:** Nov. 4/08

Sub-basin: Inglewood **Cowardin Class:** PEM, PSS. **HGM Class:** Riverine, Depress.

Estimated Wetland Size (ac): <0.1 ____ 0.1-1 ____ 1-5 ✓ 5-10 ____ >10 ____

Identified by: CH, EC **Photo No.** ____

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes [ ] No [ ]

- [ ] a. dredging
- [ ] b. filling
- [ ] c. draining
- [ ] d. clearing
- [ ] e. drainage ditches/diversions
- [ ] f. crop production
- [ ] g. other road edge

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes [✓] No [ ]

- [ ] a. clearing
- [ ] b. grazing/agriculture
- [ ] c. litter
- [ ] d. recreational overuse
- [x] e. residential development
- [x] f. other road

Hydrology

Water sources and hydroperiod:

- [ ] Ground water (perched water table, through flow…)
- [x] Surface water
- [ ] Seep
- [x] Seasonally flooded/saturated
- [ ] Permanently flooded/saturated
- [ ] Other may also be ground water fed.

Inlet/outlet:

- [ ] a. constrained, size________
- [ ] b. unconstrained
- [ ] c. natural channel
- [ ] d. none
- [ ] e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes [✓] No [ ]

Indicators of wetland hydrology:

- [ ] a. inundation
- [✓] b. saturated in upper 12"
- [ ] c. water marks
- [ ] d. drift lines
- [ ] e. sediment deposits
- [ ] f. drainage patterns in wetlands
- [ ] h. water-stained leaves
- [ ] i. other ________

Soil

Is the wetland mapped on hydric soil? Yes [ ] No [ ]

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: Invasive Species? Yes (%) -30 No ___

Bracken fern, ALRU, POMA, PHAR, RUAR, Salix sp, THPL
sword fern/hummocks
(-holly)

Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1		2	✓	≥ 3	
Degree of interspersion:	Low		Mod	✓	High	

Vegetation connectivity to other habitats?

Food sources or habitat features for wildlife? some

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [✓] No [ ]

- [✓] a. grass-lawn
- [✓] b. herbaceous-native
- [ ] c. scrub-shrub
- [✓] d. forested
- [ ] f. other ___

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [ ] a. % no buffer
- [ ] b. % <25 ft
- [95] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [✓] a. restoration
- [ ] b. creation
- [ ] c. enhancement
- [ ] d. preservation

Notes: boarderline wetland; could only see end from road, likely already delineated

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 1577 **Observer(s):** CH EC **Date:** Dec 4/00

FUNCTION	CRITERIA: LOW RATING	CRITERIA: MODERATE RATING	CRITERIA: HIGH RATING
Water Quality Improvement	___ rapid flow through wetland	___ moderate flow through wetland	✓ little or no flow present
	___ <50% vegetation density	___ 50-80% vegetation density	✓ >80% vegetation density
	___ no proximity to pollutants	✓ downstream from non-point pollutants	___ downstream from point discharges
Evaluation: ______	✓ detains <25% overland runoff	___ detains 25-50% overland runoff	___ detains >50% overland runoff
Flood/Storm Water Control	___ size <5 acres	✓ size 5-10 acres	___ size >10 acres
Evaluation: ______	✓ riverine, ~~shallow depression~~	___ mid-sloped wetland	___ lake, depressions, headwaters, bogs
Groundwater Recharge	___ size <5 acres	___ size 5-10 acres	___ size >10 acres
	✓ temporarily saturated/inundated	___ seasonally saturated/inundated	___ permanently inundated
Evaluation: ______	___ springs present outflow>inflow	✓ outflow=inflow	___ outflow<inflow
Natural Biological Support	___ size <5 acres	✓ size 5-10 acres	___ size >10 acres
	___ isolated systems associated with ephemeral surface water	✓ associated with permanent surface water	___ associated with permanent open water
	___ one habitat type	✓ two habitat types	___ three or more habitat types
	___ little or no interspersion of habitats	✓ some habitat interspersion	___ habitats highly interspersed
	___ low plant diversity	✓ moderate plant diversity	___ high plant diversity
	___ few, if any habitat features present	___ some habitat features present	✓ several habitat features present
	___ adjacent buffers primarily disturbed and/or developed	✓ buffers somewhat disturbed and/or developed	___ buffers generally undisturbed native vegetation and undeveloped
	___ few connections to other habitat types	✓ some connection to other habitat types	___ significant connections to high quality habitat types
Evaluation: ______	___ Agricultural land or low vegetation structure	✓ moderate vegetation structure	___ high vegetation structure
Erosion/Shoreline Protection	___ sparse grass/forbs or not vegetation	___ sparse woody vegetation or dense herb vegetation	✓ dense woody vegetation
Evaluation: ______			

Sammamish Basin Plans
Wetland Field Data Form

Wetland No: 15803 Location: between 224th Ave SE 3 Date: Dec 4 '08

Sub-basin: E Inglewood Cowardin Class: PEM HGM Class: Riverine

Estimated Wetland Size (ac): <0.1 ____ 0.1-1 ✓ 1-5 ____ 5-10 ____ >10 ____

Identified by: ____________ Photo No. ____

Wetland Condition

Evidence of hydrologic alterations? If yes, indicate type. Yes [✓] No [ ]

- [ ] a. dredging
- [ ] b. filling
- [ ] c. draining
- [✓] d. clearing
- [✓] e. drainage ditches/diversions
- [✓] f. crop production
- [ ] g. other ____________

Apparent impacts/threats to wetland from human use? If yes, indicate type. Yes [✓] No [ ]

- [ ] a. clearing
- [✓] b. grazing/agriculture
- [ ] c. litter
- [ ] d. recreational overuse
- [✓] e. residential development
- [ ] f. other ____________

Hydrology

Water sources and hydroperiod:

- [ ] Ground water (perched water table, through flow…)
- [✓] Surface water
- [ ] Seep
- [ ] Seasonally flooded/saturated
- [ ] Permanently flooded/saturated
- [ ] Other ____________

Inlet/outlet:

- [ ] a. constrained, size____________
- [ ] b. unconstrained
- [ ] c. natural channel
- [ ] d. none
- [✓] e. could not locate

Hydrologic connectivity to other wetlands and streams? Yes [ ] No [ ]

Indicators of wetland hydrology:

- [ ] a. inundation
- [ ] b. saturated in upper 12"
- [ ] c. water marks
- [ ] d. drift lines
- [ ] e. sediment deposits
- [ ] f. drainage patterns in wetlands
- [ ] h. water-stained leaves
- [✓] i. other Vegetation

Soil

Is the wetland mapped on hydric soil? Yes [ ] No [ ]

Soil profile: —

Sammamish Basin Plans
Wetland Field Data Form

Vegetation

Dominant Species: ______ Invasive Species? Yes (%) 10 No ___

POA,

	<50		50-80		>80	
Approximate age of dominant woody vegetation (years)?	<50	✓	50-80		>80	
# of habitat types:	1	✓	2		≥ 3	
Degree of interspersion:	Low	✓	Mod		High	

Vegetation connectivity to other habitats? yes

Food sources or habitat features for wildlife? no

Buffer

Does the wetland have a buffer anywhere along its perimeter? Yes [ ] No [✓]

- [✓] a. grass-lawn
- [ ] b. herbaceous-native
- [ ] c. scrub-shrub
- [ ] d. forested
- [ ] f. other ______

If yes, what percentage of the wetland edge is protected by buffers of the width categories listed below? (Note: total should add to 100%)

- [90] a. % no buffer
- [ ] b. % <25 ft
- [ ] c. % 25-50 ft
- [ ] d. % 50-100 ft
- [ ] e. %>100 ft

Mitigation Opportunities

Are any mitigation opportunities present nearby? Yes [✓] No [ ]

- [✓] a. restoration
- [ ] b. creation
- [ ] c. enhancement
- [ ] d. preservation

Notes: restore buffer remove [illegible]

Sammamish Basin Plans
Rapid Qualitative Function Assessment Form

Wetland No. 1580B Observer(s): CH, EC Date: Dec 4/08

FUNCTION	CRITERIA: LOW RATING	MODERATE RATING	HIGH RATING
Water Quality Improvement	rapid flow through wetland	moderate flow through wetland	✓ little or no flow present
	<50% vegetation density	✓ 50-80% vegetation density	>80% vegetation density
	no proximity to pollutants	✓ downstream from non-point pollutants	downstream from point discharges
Evaluation:	✓ detains <25% overland runoff	detains 25-50% overland runoff	detains >50% overland runoff
Flood/Storm Water Control	✓ size <5 acres	size 5-10 acres	size >10 acres
Evaluation:	riverine, shallow depression (circled)	mid-sloped wetland	✓ lake, depressions, headwaters (circled), bogs
Groundwater Recharge	✓ size <5 acres	size 5-10 acres	size >10 acres
	✓ temporarily saturated/inundated	seasonally saturated/inundated	permanently inundated
Evaluation:	springs present outflow>inflow	outflow=inflow	outflow<inflow
Natural Biological Support	✓ size <5 acres	size 5-10 acres	size >10 acres
	isolated systems associated with ephemeral surface water	✓ associated with permanent surface water	associated with permanent open water
	✓ one habitat type	two habitat types	three or more habitat types
	✓ little or no interspersion of habitats	some habitat interspersion	habitats highly interspersed
	✓ low plant diversity	moderate plant diversity	high plant diversity
	✓ few, if any habitat features present	some habitat features present	several habitat features present
	✓ adjacent buffers primarily disturbed and/or developed	buffers somewhat disturbed and/or developed	buffers generally undisturbed native vegetation and undeveloped
	few connections to other habitat types	✓ some connection to other habitat types	significant connections to high quality habitat types
Evaluation:	✓ Agricultural land or low vegetation structure	moderate vegetation structure	high vegetation structure
Erosion/Shoreline Protection	✓ sparse grass/forbs or not vegetation	sparse woody vegetation or dense herb vegetation	dense woody vegetation
Evaluation:			

APPENDIX C

Field Data Comparison – 1990 and 2008

Table C-1. Comparison of Existing Conditions (2008) to 1990 Conditions

George Davis Creek Existing Conditions (2008) compared to 1990 King County Documented Conditions
George Davis Creek is referred to as Tributary 0144 in King County Existing Conditions Report

KC Subcatchment	Approx. RM	1990 Description of Conditions	2008 Description of Conditions
I-1	0.0- 0.2	Culvert system from Lake Sammamish shore upstream under single family home and driveway. Culvert capacity insufficient to accommodate sediment load. Barrier to fish.	Stream is still in a culvert system under a single family residence. Currently stream flow is being diverted from ELSP around the house as it is being rebuilt. Stream will be partially daylighted in new configuration, but will still be under the house.
I-1	0.0- 0.2	Channel realignment and culvert placements are inadequate for peak storm flows at E. Lake Sammamish Parksway and under the single family resident lot adjacent to Lake Sammamish.	Several large stormwater control structures upstream of ELSP that lead to culvert under road. Bypass structures located here- ponding in this area.
I-1	0.0-0.2	Culverts and channelization are restricting flow capacity and sediment transport.	
I-1	0.05	Stream flows and sediment load exceeded culvert and channel capacity at E. lake Sammamish Parkway, R/R berm culvert, and culvert under single family residence. Flows and sediment deposition caused closure of E. Lake Samammish Parkway on January 11, 1990 and two homes received flood flow in the basement.	Incised channel just upstream of ELSP, becomes more incised upstream from 2.5 to 6 feet deep. Unstable left bank adjacent to yard.
	0.08		Fence across channel, stream enters steep forested ravine. Entrenched channel, mass-wasting deposits.
	0.09		Valley widens, stream channel spilts into two separate channels. Lots of cobbles, some boulders, not entrenched.
I-1	0.1	Bank erosion probably due to recent high flows.	

Table C-1. Comparison of Existing Conditions (2008) to 1990 Conditions

KC Subcatchment	Approx. RM	1990 Description of Conditions	2008 Description of Conditions
I-1	0.17 - 0.37	A concrete weir is located at approximately RM 0.17. The weir filled with sediemtns and storm flows breached the dam around the left abutment. Channel has incised through the sediments.	Concrete weir spans full valley (3.5 ' high). Large rusted tank downstream of weir. Small hole in weir wall allows water to pass through. Check dams with filter fabric and logs located downstream of weir.
I-1	0.2	Potential fish blockage from water supply diversion dam. Dam failure during 1/90 storm.	
	0.18		Upstream of weir, 12- 18 ' dia solid black stormpipe with energy dissipation about 20 feet above valley floor on right bank slope.
I-1	0.08- 0.75	High velocity flows causing ditch erosion along Inglewood Hill Road.	
I-1	0.5	Water supply check dam was breached at left bank abutment at RM 0.5 mile. Sediment source for future storm flows.	
I-1	0.2 - 0.8	Channel sedimentation. Due to local channel incision and channel scouring within RM 6.8 - 1.2. (???)	Rootwad structures every 50- 100' along stream channel
I-1	0.3- 0.4	Extensive historic and recent slide/slump topography including eroding banks.	Evidence of slumping and sliding particularly on right bank. Old road bench?? Present on right bank. No evidence of recent landslides.
	0.5		Very large landslide left bank (60-100' x 60'x10") Vegetated with salmonberries, sword ferns
	0.6		landslide on left bank (40'x40'x5'), saturated side slopes in clay unit at the base
	0.62		Ravine on left bank, slides in this area, more sloughing on both banks
	0.7		Left bank landslide (60'x'40'x8'), saturated at bottom. Braided reach, wide valley (~100 feet), lots of cobbles, seeps coming in on left bank.

Table C-1. Comparison of Existing Conditions (2008) to 1990 Conditions

KC Subcatchment	Approx. RM	1990 Description of Conditions	2008 Description of Conditions
I-1	0.37 - 0.8	Steep-sloped ravine is currently heavily forested. Increased flows evident in recent channel incision. Debris jams and boulder armoring of channel are retaining sediments and reducing incision. Lateral erosion and bank cutting has resulted in several slides and slumping.	
I-1	0.8	Fish blockage due to long culvert with no light	Two rusted culverts, stream is partially in culverts, but mostly not. Metal conduit pipe (1 1/2") in channel.
I-1	0.8	On 214th Ave NE at the end of the road (a dead end), there is an overgrazed pasture, and an adjacent pasture which was noted as having bedding material spread across the field.	landslide on left bank (25'x20'x5')
	0.82		End of wetted channel. Smaller gravel/cobbles in dry channel.
	1		3.5'x5' squashed culverts at road crossing.
I-1, I-2	0.8- 1.2	Manmade trapezoid channel through single family development. Channel soils highly erodible sands and gravels.	
I-2	0.81- 1.27	Soils in this reach are very gravelly and appear to have a high rate of infiltration. These highly infiltrative soils have helped to mitigate flows that have been generated by current levels of development.	
I-2	0.9	Flooding of NE 4th Street approximately 6" water depth over roadway. Roadway partially washed out. Observed January 11, 1990.	

Table C-1. Comparison of Existing Conditions (2008) to 1990 Conditions

KC Subcatchment	Approx. RM	1990 Description of Conditions	2008 Description of Conditions
I-2	1	At NE 4th Street and 219th Ave NE, there exists the remains of two yard scrap (lawn clipping, sticks, and twigs) burns in the channel (on the east side). Ont eh west side of the channel, a pile of gravel, soil, debris, and lawn clipping along the side of the channel was observed.	
I-1, I-2	0.8 - 1.2	Manmade trapezoid channel through single family development. Channel soils highly erodible sands and gravels.	
I-3	1.2	Water over the roadway. Channel flowing full. Observed January 11, 1990.	
I-3	1.7	West of 228th Ave SE and north of SE 1st Street, there is a llama farm. This field was noted as being over-used.	
I-4	1.8	Sampling site ELSWQ2: TSS, turbidity, TP, fecal coliform, and zinc concentrations were elevated in the 4/34/90 storm. TP was 0.09 mg/L. Agricultural and land use are the likely source of these contaminants.	
I-5	1.88- 2	Stream outletting from wetland exhibits signs of channel dredging and debris removal. The right bank has been cleared of all riparian vegetation outward from the stream . An HPA violation has likely occurred.	

Table C-1. Comparison of Existing Conditions (2008) to 1990 Conditions

KC Subcatchment	Approx. RM	1990 Description of Conditions	2008 Description of Conditions
I-5	2	Sampling site ELSWQ3: TSS, turbidity, TP, fecal coliform, copper, and zinc concentrations were elevated in the 4/34/90 storm. TP and fecal coliform concentrations were 0.096 mg/L and 2100 organisms/100 mL, respectively. Agricultural activity is the likely source of these contaminants.	
I-5	2- 2.2	Forested wetland provides attenuation for increased flows from a development upstream (approx. RM 2.5)	
I-5, I-6	2.2- 2.3	Horse pasture. Stream is confined to a gully which outlets a pond just upstream of a private road.	
I-7	2.5- 2.63	Development has cleared and filled a forested wetland and installed a pond (trout), not designed for R/D use. Cleared area around pond has no TESC. SEPA DNS posted for area adjacent to wetland.	
I-7	2.63- 3.2	Forested wetland contributes to attenuate flows from increased development in headwater region.	
I-7	2.63	Wetland is contributing to mitigation of increased runoff from current developments	
I-7	2.63	Forested stream corridor	
I-7	Wetland 18	Recent clearing and gradient buffers. Recent logging in the wetlands.	
I-7	Wetland 66	Some evidence of fill and yard waste.	
I-3	Trib 0144C, RM 0.25	Water over roadway at 222nd Pl NE. Water depth approx. 4 - 6". Observed January 11, 1990.	

Table C-1. Comparison of Existing Conditions (2008) to 1990 Conditions

KC Subcatchment	Approx. RM	1990 Description of Conditions	2008 Description of Conditions
I-3	Wetland 11	Recent clearing and gradient buffers. Recent logging in the wetlands.	
I-3	Trib 0144E, RM 0.2	Commercial development has occurred on the south side of the intersection of Inglewood Hill Road and 228th Ave SE. The area hosts a variety of businesses including neighborhood commercial activities, dry cleaning, and two gas stations. Potential pollutants associated with commercial development, particularly dry cleaning and gas stations, are cleaning chemicals, detergents, oil, grease, fuel, and other petroleum by-products.	
I-3	0.4	Near 8th Ave NE on 231st Pl NE, a small hobby farm was noted with a single horse in an overgrazed pasture.	
I-3	0.4/Wetland 39	Triple J Farms (23404 8th NE) is a llama farm. One field was under water with animals using the pasture area during site visits on April 14, 1990 and may 15, 1990.	
I-3	0.1	Sampling site ELSWQ1: TSS, turbidity, TP, fecal coliform, copper and zince concentrations were elevation in the 4/34/1990 storm. Fecal colifroms were 3400 organisms/100 mL. TP was 0.14 mg/L. Agricultural activity is the likely source of these pollutants.	
I-3	Wetland 59	Lumber trimmings and other debris in wetland.	

APPENDIX D

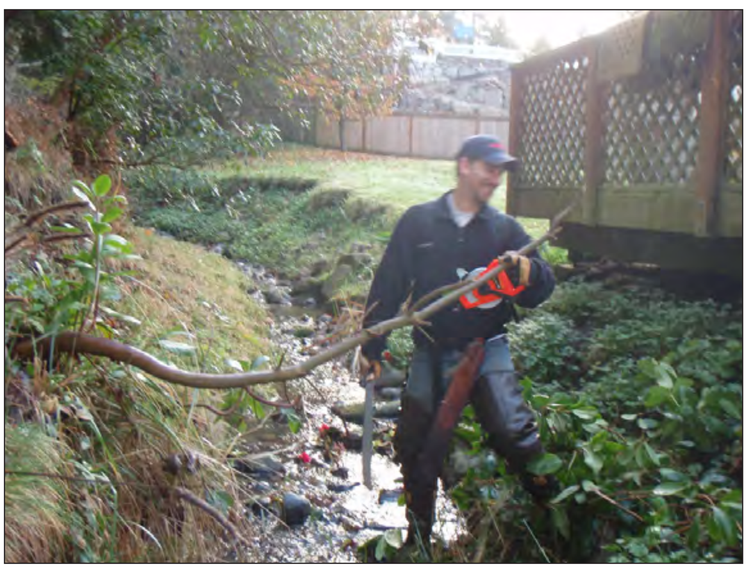
Photo Logs

Station 1. George Davis Creek 150 feet upstream from East Lake Sammamish Parkway.

Station 2. George Davis Creek 250 feet upstream of East Lake Sammamish Parkway.

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 3. Bank erosion and stream downcutting on George Davis Creek 300 feet upstream of East Lake Sammamish Parkway.



Station 4. George Davis Creek 350 feet upstream from Lake Sammamish Parkway.

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 5. George Davis Creek 500 feet upstream from Lake Sammamish Parkway.

Station 6. George Davis Creek 635 feet upstream from East Lake Sammamish Parkway. (note: old water supply dam)

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 7. Stormwater pipe and outfall on right bank of George Davis Creek 680 feet upstream of East Lake Sammamish Parkway.

Station 8. George Davis Creek 750 feet upstream from Lake Sammamish Parkway.

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 9. Old road bed on right bank of George Davis Creek 800 feet upstream of East Lake Sammamish Parkway.

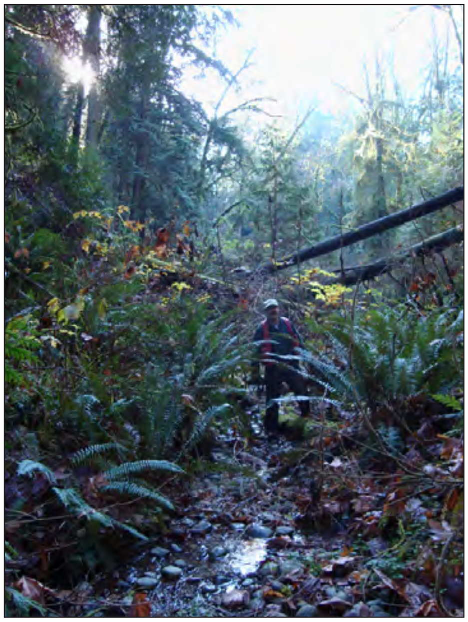
Station 10. Landslide on left bank of George Davis Creek 915 feet upstream from East Lake Sammamish Parkway.

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 11. George Davis Creek 1150 feet upstream from Lake Sammamish Parkway.

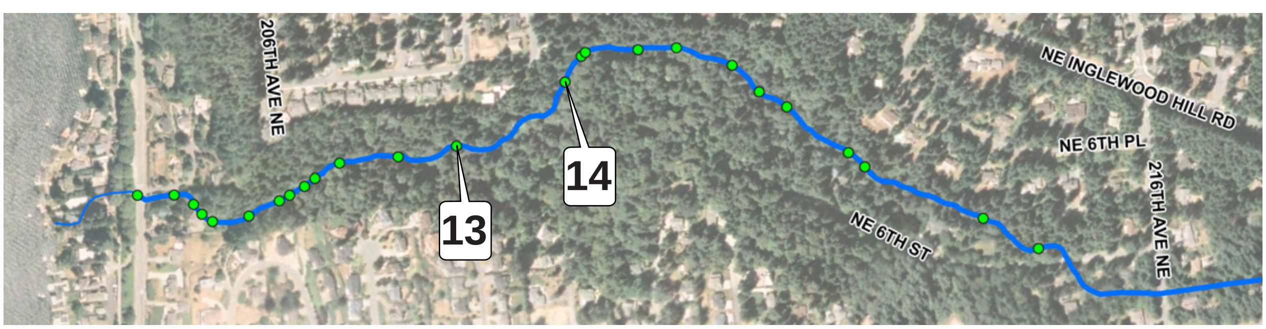
Station 12. George Davis Creek 1400 feet upstream from Lake Sammamish Parkway.

Parametrix 558-3847-002/01(07) 5/09 (B)



Station 13. George Davis Creek 1960 feet upstream of East Lake Sammamish Parkway.

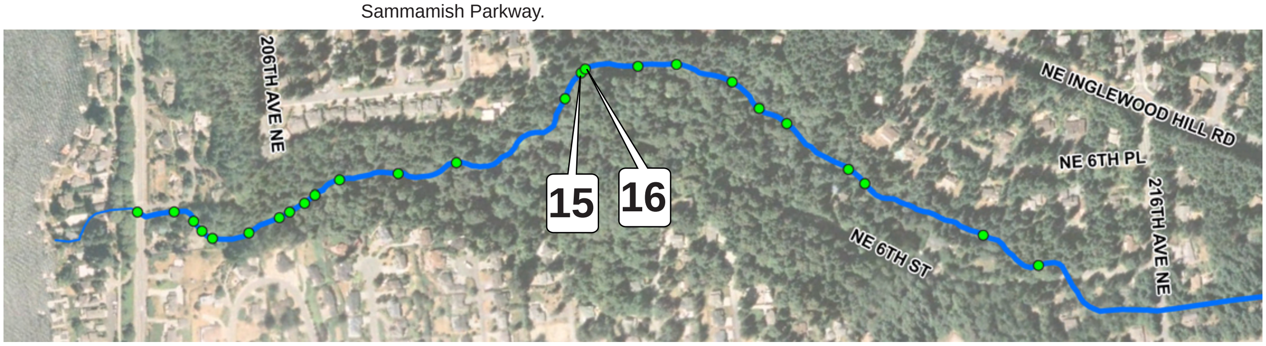
Station 14. George Davis Creek 2080 feet upstream from Lake Sammamish Parkway.



Parametrix 558-3847-002/01(07) 5/09 (B)

Station 15. George Davis Creek in old culverts 1200 feet upstream of East Lake Sammamish Parkway.

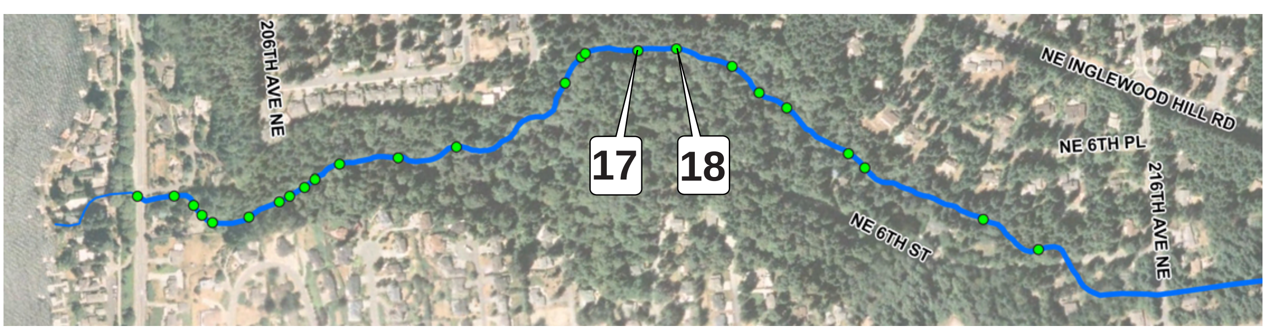
Station 16. Left bank slump on George Davis Creek 2315 feet upstream from Lake Sammamish Parkway.



Parametrix 558-3847-002/01(07) 5/09 (B)

Station 17. George Davis Creek 2465 feet upstream from Lake Sammamish Parkway.

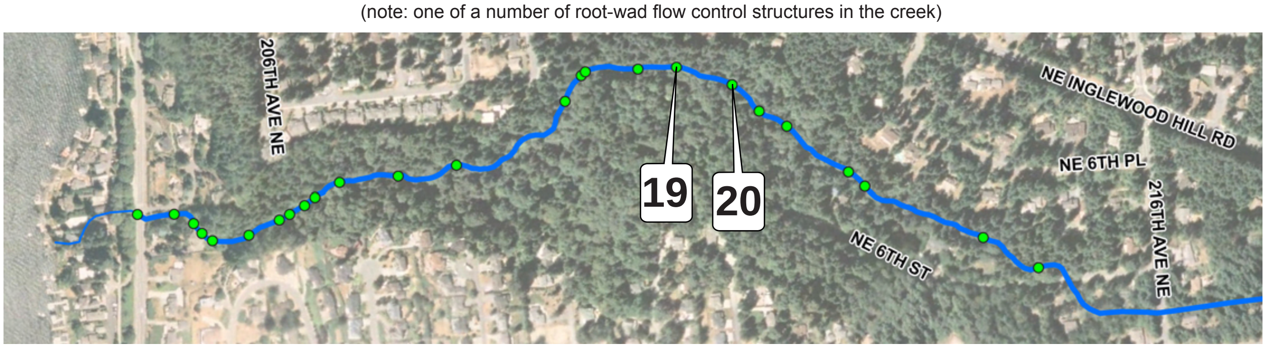
Station 18. George Davis Creek 2700 feet upstream from Lake Sammamish Parkway.



Parametrix 558-3847-002/01(07) 5/09 (B)

Station 19. George Davis Creek 2700 feet upstream from Lake Sammamish Parkway.
(note: the stream was dry upstream of this location)

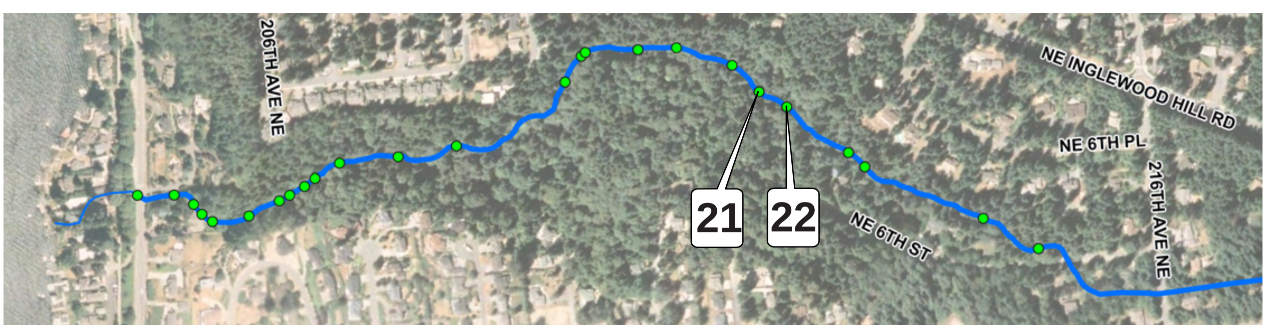
Station 20. George Davis Creek 2850 feet upstream from Lake Sammamish Parkway.
(note: one of a number of root-wad flow control structures in the creek)



Parametrix 558-3847-002/01(07) 5/09 (B)

Station 21. George Davis Creek 2975 feet upstream from Lake Sammamish Parkway.

Station 22. George Davis Creek 3285 feet upstream from Lake Sammamish Parkway.



Parametrix 558-3847-002/01(07) 5/09 (B)

Station 23. Left bank stormwater outfall 3370 feet upstream from East Lake Sammamish Parkway.

Station 24. George Davis Creek 3885 feet upstream from Lake Sammamish Parkway.

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 25. George Davis Creek 4150 feet upstream from Lake Sammamish Parkway.

Station 26. George Davis Creek 4200 feet upstream from Lake Sammamish Parkway.
(note: dual 5-foot diameter culverts under NE 6th Street)

Parametrix 558-3847-002/01(07) 5/09 (B)

Station 27. George Davis Creek 4800 feet upstream from Lake Sammamish Parkway (note dual 6-foot wide by 3-foot tall culverts under 216th Ave NE)

Station 28. George Davis Creek 4800 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 29. George Davis Creek 5000 feet upstream from Lake Sammamish Parkway (note dual 6-foot wide by 3-foot tall culverts under 218th Ave NE)

Station 30. George Davis Creek 5050 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 31. George Davis Creek 5300 feet upstream from Lake Sammamish Parkway

Station 32. Right bank stormwater outfall 5375 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 33. George Davis Creek 5530 feet upstream from Lake Sammamish Parkway (note dual 6-foot wide by 3-foot tall culverts under 219th Ave NE)

Station 34. George Davis Creek 5600 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

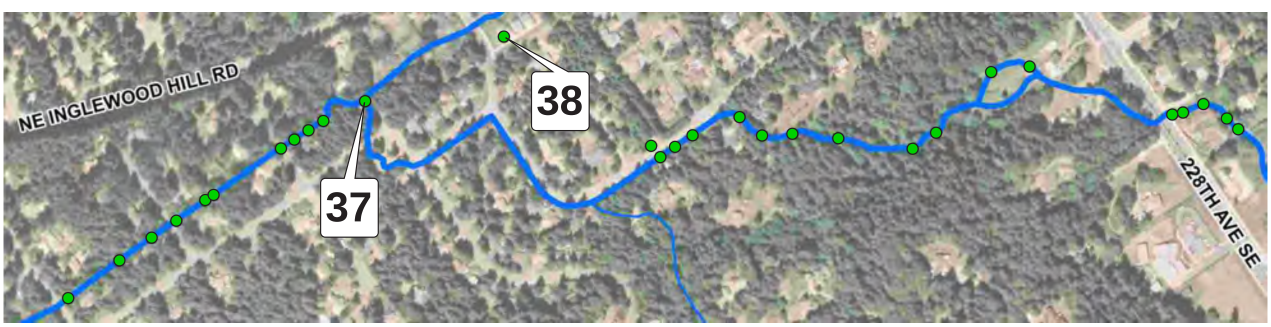
Station 35. Scour at tree roots 5660 feet upstream from Lake Sammamish Parkway

Station 36. Four foot head-cut on George Davis creek 5715 feet upstream of East Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 37. George Davis Creek 5910 feet upstream from Lake Sammamish Parkway

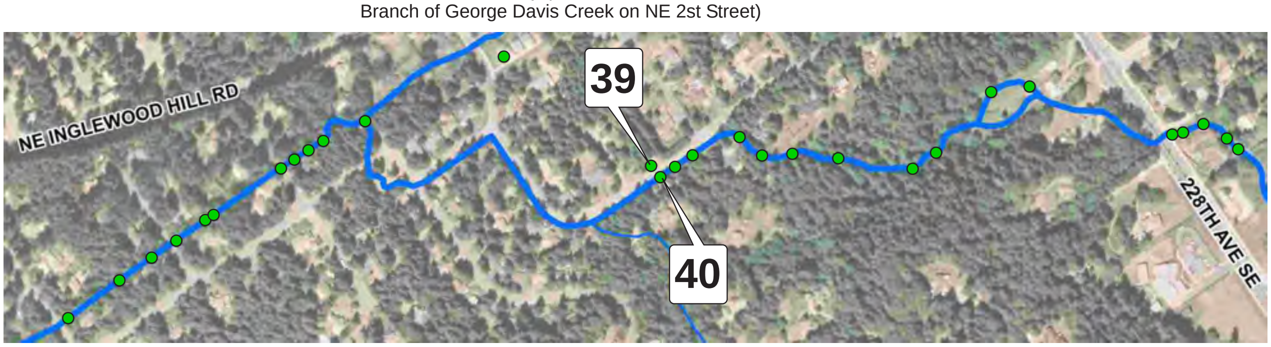
Station 38. George Davis Creek 6500 feet upstream from Lake Sammamish Parkway
(36" CMP outfall of South Branch of George Davis Creek on 222nd Ave NE)



Parametrix 558-3847-002/01(07) 6/10 (B)

Station 39. George Davis Creek 7215 feet upstream from Lake Sammamish Parkway (South Branch of George Davis Creek in storm drain)

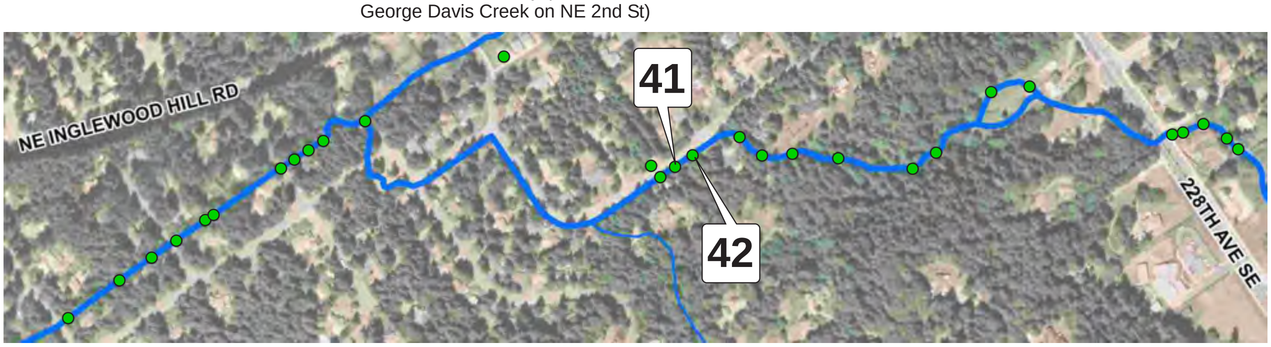
Station 40. George Davis Creek 8000 feet upstream from Lake Sammamish Parkway (inlet to 36" culvert for South Branch of George Davis Creek on NE 2st Street)



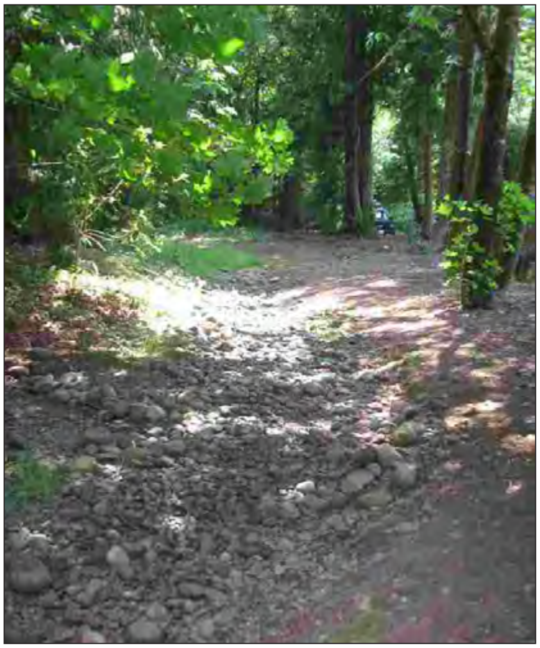
Parametrix 558-3847-002/01(07) 6/10 (B)

Station 41. George Davis Creek 8800 feet upstream from Lake Sammamish Parkway (culvert for South Branch of George Davis Creek on NE 2nd St)

Station 42. George Davis Creek 9800 feet upstream from Lake Sammamish Parkway (Culverts in South Branch of George Davis Creek on NE 2nd St)

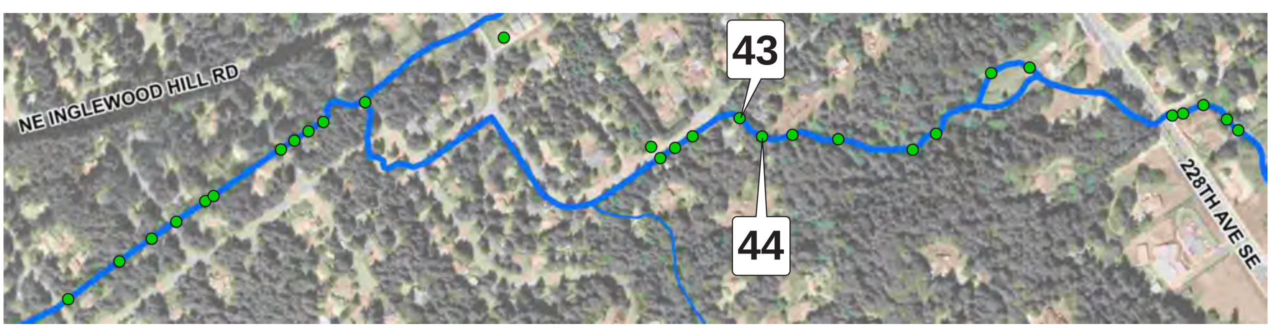


Parametrix 558-3847-002/01(07) 6/10 (B)



Station 43. South Branch of George Davis Creek 9960 feet upstream from Lake Sammamish Parkway

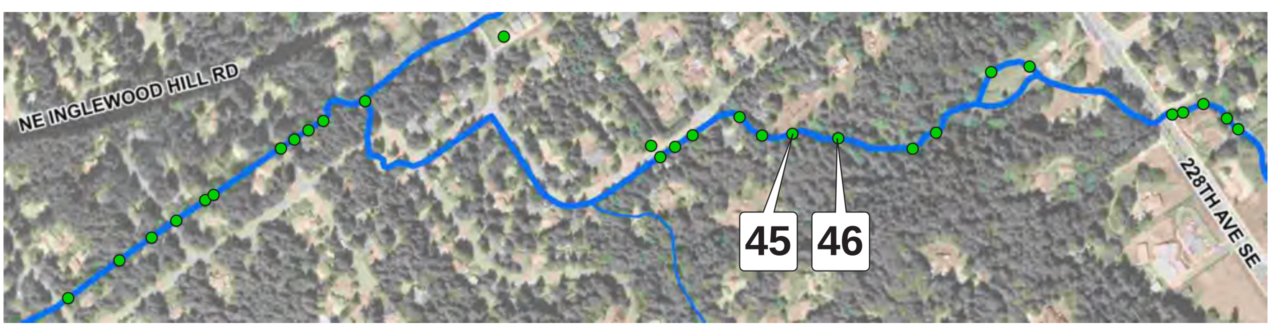
Station 44. South Branch of George Davis Creek 10,085 feet upstream from Lake Sammamish Parkway



Parametrix 558-3847-002/01(07) 6/10 (B)

Station 45. South Branch of George Davis Creek 10,185 feet upstream from Lake Sammamish Parkway (100 feet downstream of wetland)

Station 46. South Branch of George Davis Creek 10,385 feet upstream from Lake Sammamish Parkway (in wetland)



Parametrix 558-3847-002/01(07) 6/10 (B)

Station 47. Left bank possible tributary to South Branch of George Davis Creek 10,685 feet upstream from Lake Sammamish Parkway (in wetland)

Station 48. South Branch of George Davis Creek 10,750 feet upstream from Lake Sammamish Parkway (in wetland)

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 49. South Branch of George Davis Creek 11,075 feet upstream from Lake Sammamish Parkway (upstream of forested wetland section)

Station 50. South Branch of George Davis Creek 11,925 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 51. South Branch of George Davis Creek 13,000 feet upstream from Lake Sammamish Parkway (Culvert inlet at 228th Ave SE)

Station 52. South Branch of George Davis Creek 13,050 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 53. South Branch of George Davis Creek 13,150 feet upstream from Lake Sammamish Parkway

Station 54. South Branch of George Davis Creek 13,240 feet upstream from Lake Sammamish Parkway

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 55. South Branch of George Davis Creek 13,300 feet upstream from Lake Sammamish Parkway

Station 56. South Branch of George Davis Creek 13,775 feet upstream from Lake Sammamish Parkway (36" culvert inlet in wetland; 12" culvert from pond)

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 57. South Branch of George Davis Creek 13,775 feet upstream from Lake Sammamish Parkway (in wetland from inlet of culvert)

Station 58. South Branch of George Davis Creek 14,075 feet upstream from Lake Sammamish Parkway (36" culvert outlet looking downstream at Eastside Catholic driveway and 228th Ave)

Parametrix 558-3847-002/01(07) 6/10 (B)

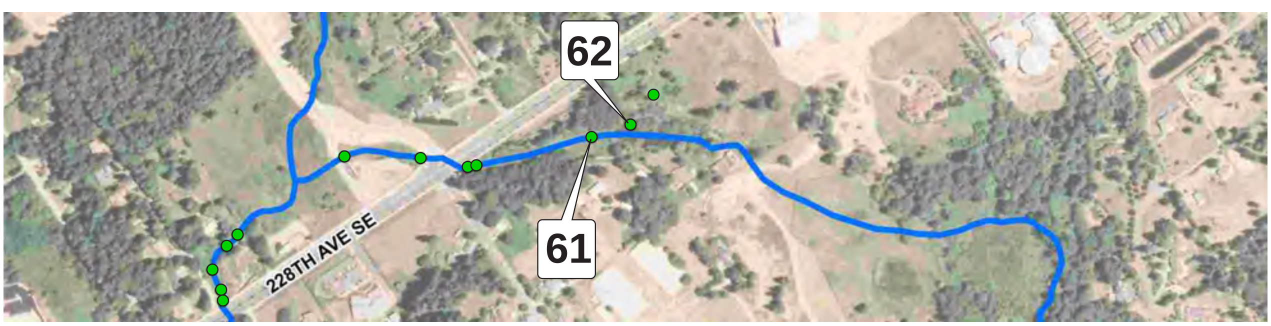
Station 59. South Branch of George Davis Creek 14,275 feet upstream from Lake Sammamish Parkway (36" culvert inlet; SW corner of 8th ST and 228th Ave)

Station 60. South Branch of George Davis Creek 14,325 feet upstream from Lake Sammamish Parkway (upstream of culvert, no defined channel

Parametrix 558-3847-002/01(07) 6/10 (B)

Station 61. South Branch of George Davis Creek 14,825 feet upstream from Lake Sammamish Parkway (looking DS from pond edge; uprooted trees fall uphill)

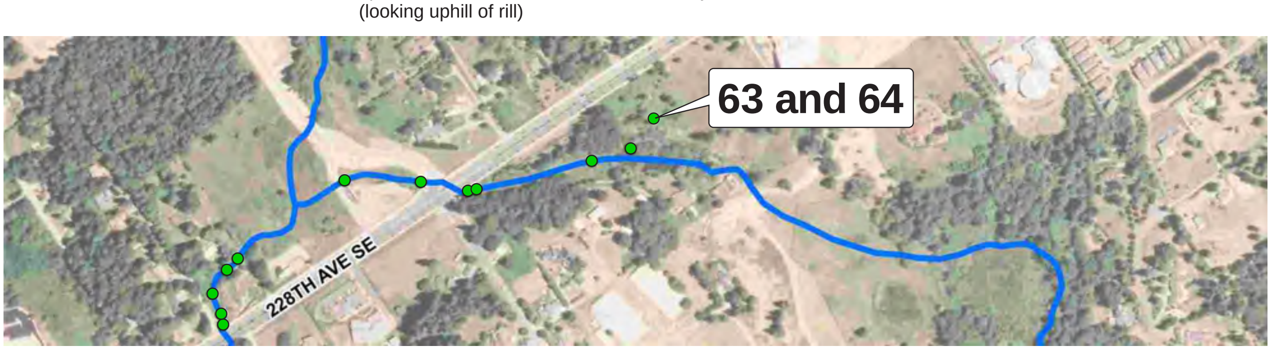
Station 62. South Branch of George Davis Creek 14,925 feet upstream from Lake Sammamish Parkway (east shore of pond, under tree canopy)



Parametrix 558-3847-002/01(07) 6/10 (B)

Station 63. South Branch of George Davis Creek 15,065 feet upstream from Lake Sammamish Parkway (deep rill 2.5' wide by 2' deep; off shore of pond)

Station 64. South Branch of George Davis Creek 15,065 feet upstream from Lake Sammamish Parkway (looking uphill of rill)



Parametrix 558-3847-002/01(07) 6/10 (B)

APPENDIX E

Specific Conceptual Project Alternatives

Inglewood Basin Plan
Project Description

Project Number:	CIP-1
Project Name:	217th Ave NE Drainage Improvement
Description:	Modify road drainage on 217th Avenue NE by adding curbs and catch basins to convey flow away from adjacent residence that experiences flooding due to road runoff.
Purpose:	Eliminate flooding at local residence.
Project Benefits:	Better road drainage, less impacts to homeowners.
Assumptions:	City maintenance staff will construct project.
Estimated Cost:	$59,000
Project Partners:	None
Priority:	Low

CITY OF SAMMAMISH
CIP IMPROVEMENTS
Preliminary Opinion of Probable Cost

Draft

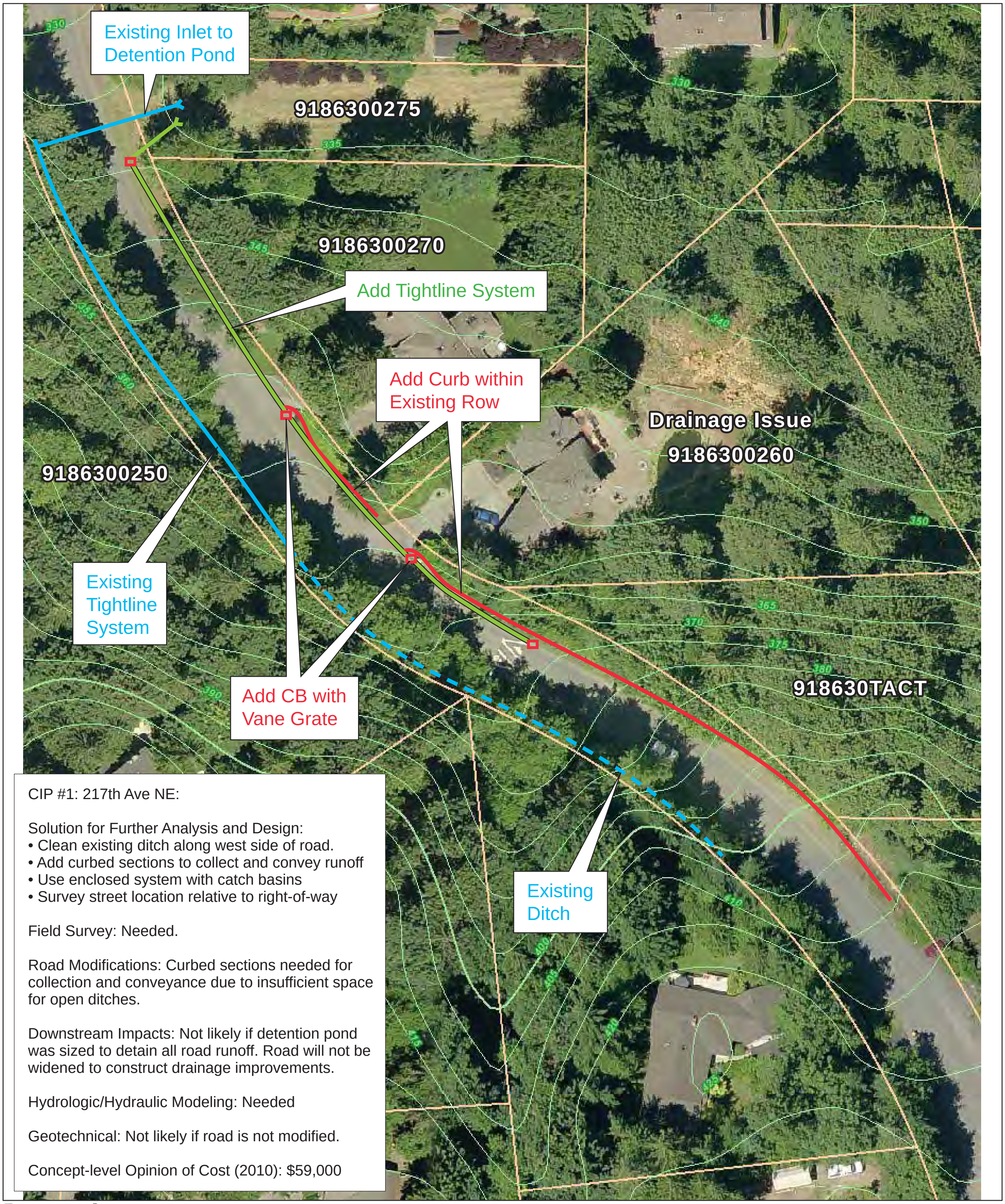
CIP #: 1
Project Name: 217th Ave NE Drainage Improvement
Prepared By: Chad Wiggins **Checked By:**

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount	Percent of Construction Cost
1	1	LS	Mobilization	$1,800.00	$1,800	6.57%
2	1	LS	Traffic Control	$500.00	$500	1.83%
3	1	LS	Restoration	$200.00	$200	0.73%
4	1	LS	Erosion/Sedimentation Control	$500.00	$500	1.83%
5	0.1	ACRE	Ditch Cleaning	$10,000.00	$1,000	3.65%
6	460	LF	Extruded Curb (Item 6727)	$8.00	$3,680	13.44%
7	3	EA	Rectangular Frame and Grate(1052)	$300.00	$900.00	3.29%
8	1	EA	Locking Solid Metal Cover and Frame For CB(311(	$400.00	$400.00	1.46%
9	300	LF	Schedule A Storm Sewer Pipe 12-inch Diam.(1180)	$30.00	$9,000.00	32.86%
10	4	EA	Catch Basin Type 1(3091)	$1,500.00	$6,000.00	21.91%
11	155	SY	AC Road, 2", 4" rock, First 2500 SY	$22.00	$3,410.00	12.45%
				Subtotal =	**$27,390**	100.00%

Contingency	30.0%	$8,217
Sales Tax	9.5%	$2,602
Planning Level Construction Cost =		**$38,200**
Property Acquisition		$0.00
Environmental Permitting and Documentation	10.0%	$3,820
Surveying	10.2%	$3,882
Administration	5.0%	$1,910
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$11,460
TOTAL =		**$59,000**

PROJECT DESCRIPTION: Construct a curb along the east side of the road with an enclosed collection and conveyance system. Clean existing ditch along west side of road.

ASSUMPTIONS:
Mobilization equals approximately 7-percent of Subtotal
Restoration equals approximately 1-percent of Subtotal
Traffic equals approximately 2-percent of Subtotal
Pipe size and length is estimated only
Erosion/Sedimentation Control equals approximately 1-percent of Subtotal ($500 minimum)
Estimate does not include obtaining land or easements



CIP #1: 217th Ave NE:

Solution for Further Analysis and Design:
- Clean existing ditch along west side of road.
- Add curbed sections to collect and convey runoff
- Use enclosed system with catch basins
- Survey street location relative to right-of-way

Field Survey: Needed.

Road Modifications: Curbed sections needed for collection and conveyance due to insufficient space for open ditches.

Downstream Impacts: Not likely if detention pond was sized to detain all road runoff. Road will not be widened to construct drainage improvements.

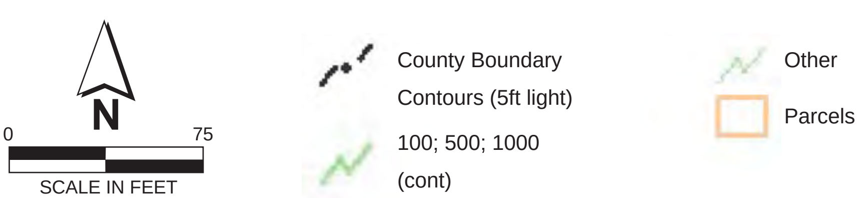
Hydrologic/Hydraulic Modeling: Needed

Geotechnical: Not likely if road is not modified.

Concept-level Opinion of Cost (2010): $59,000

Parametrix 558-3847-002/02(05) 6/10 (B)

Source: King County iMAP - Stormwater (http://www.metrokc.gov/GIS/iMAP)



Capital Improvement Project
217th Ave NE

Inglewood Basin Plan
Project Description

Project Number: CIP-2A and CIP-2B

Project Name: 228th Ave NE Drainage Improvement

Description: Modify discharge from road runoff to prevent downstream erosion and damage to natural resources.

Purpose: Reduce impacts to natural resources and prevent slope failure.

Project Benefits: Reduced erosion and damage to trees.

Assumptions: There are two alternatives for this project, including (1) conveying existing flow to the base of the slope with a tightline pipe, and (2) conveying existing flow within the road right-of-way to a discharge point at SE 4th Street.

Estimated Cost: $55,000 to $78,000, depending on alternative

Project Partners: None

Priority: Medium

CITY OF SAMMAMISH
CIP IMPROVEMENTS
Preliminary Opinion of Probable Cost

Draft

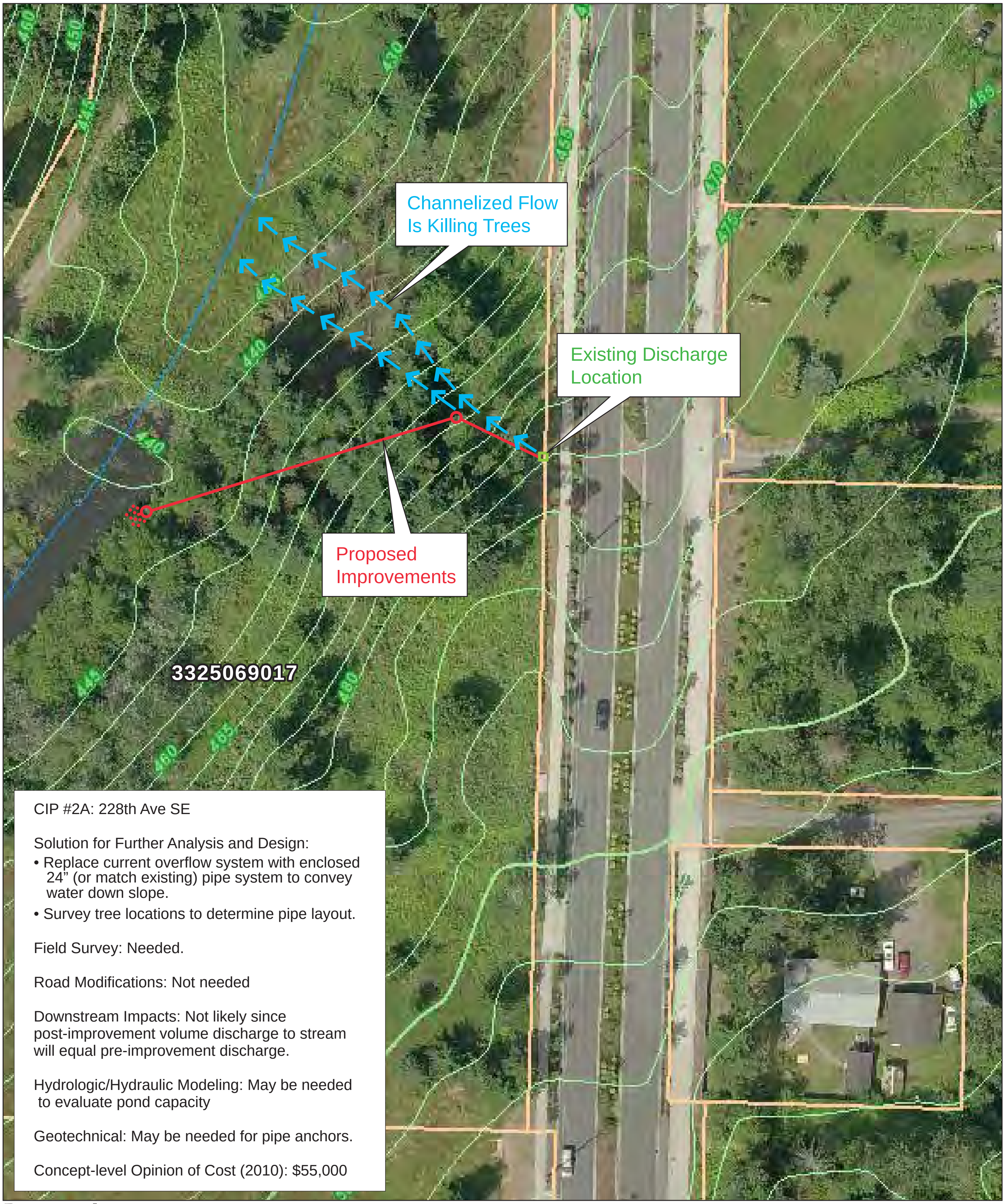
CIP #: 2A
Project Name: 228th Ave SE Drainage Improvement
Prepared By: Chad Wiggins **Checked By:** R. Cushman

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount	Percent of Construction Cost
1	1	LS	Mobilization	$1,600.00	$1,600	6.37%
2	1	LS	Traffic Control	$700.00	$700	2.79%
3	1	LS	Restoration	$400.00	$400	1.59%
4	1	LS	Erosion/Sedimentation Control	$500.00	$500	1.99%
5	0.3	ACRE	Clearing And Grubbing (0025)	$10,000.00	$3,000	11.95%
6	3	EA	Pipe Anchor	$300.00	$900.00	3.59%
7	2	EA	Locking Solid Metal Cover and Frame For CB(3110)	$400.00	$800.00	3.19%
8	225	LF	Corrugated Polyethylene Storm Sewer Pipe 24"	$40.00	$9,000.00	35.86%
9	1	EA	Catch Basin Type 2 - 48-inch Diam. With Bird Cage	$3,200.00	$3,200.00	12.75%
10	1	EA	Catch Basin Type 2 - 48-inch Diam.(3105)	$3,000.00	$3,000.00	11.95%
11	1	EA	Connect to drainage structure	$2,000.00	$2,000.00	7.97%
				Subtotal =	**$25,100**	100.00%

Contingency	30.0%	$7,530
Sales Tax	9.5%	$2,385
Planning Level Construction Cost =		**$35,000**
Property Acquisition		$0.00
Environmental Permitting and Documentation	10.0%	$3,500
Surveying	10.9%	$3,805
Administration	5.0%	$1,750
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$10,500
	TOTAL =	**$55,000**

PROJECT DESCRIPTION: Connect and construct a conveyance pipe along the west side of the road within the ROW to convey the water to the existing channel at SE 4th St and 228th AVE SE

ASSUMPTIONS:
Mobilization equals approximately 7-percent of Subtotal
Restoration equals approximately 2-percent of Subtotal
Traffic equals approximately 3-percent of Subtotal
Pipe size and length is estimated only
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($500 minimum)
Estimate does not include obtaining land or easements



CIP #2A: 228th Ave SE

Solution for Further Analysis and Design:

- Replace current overflow system with enclosed 24" (or match existing) pipe system to convey water down slope.
- Survey tree locations to determine pipe layout.

Field Survey: Needed.

Road Modifications: Not needed

Downstream Impacts: Not likely since post-improvement volume discharge to stream will equal pre-improvement discharge.

Hydrologic/Hydraulic Modeling: May be needed to evaluate pond capacity

Geotechnical: May be needed for pipe anchors.

Concept-level Opinion of Cost (2010): $55,000

Parametrix 558-3847-002/02(05) 6/10 (B)

Source: King County iMAP - Stormwater (http://www.metrokc.gov/GIS/iMAP)

N

0 75

SCALE IN FEET

County Boundary

Contours (5ft light)

100; 500; 1000

Other

Parcels

Streams

Capital Improvement Project
228th Ave SE

CITY OF SAMMAMISH
CIP IMPROVEMENTS
Preliminary Opinion of Probable Cost

Draft

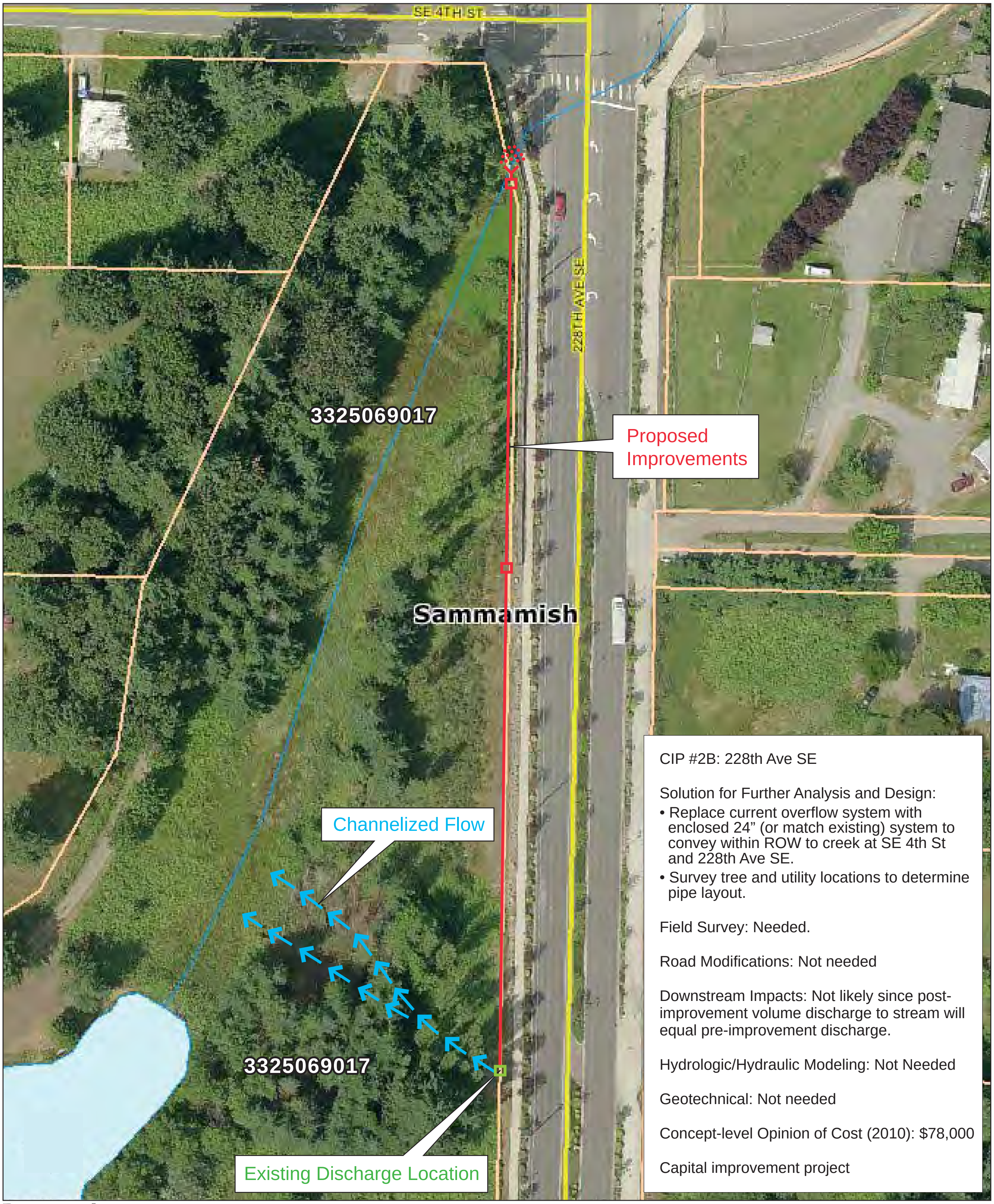
CIP #: 2B
Project Name: 228th Ave SE Drainage Improvement
Prepared By: Chad Wiggins
Checked By:

PROJECT DESCRIPTION: Connect and construct a conveyance pipe along the east side of the road to convey the water to the bottom of the hill within the right of way.

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount	Percent of Construction Cost
1	1	LS	Mobilization	$2,400.00	$2,400	6.59%
2	1	LS	Traffic Control	$1,000.00	$1,000	2.75%
3	1	LS	Restoration	$600.00	$600	1.65%
4	1	LS	Erosion/Sedimentation Control	$600.00	$600	1.65%
5	0.1	ACRE	Clearing And Grubbing (0025)	$10,000.00	$1,200	3.30%
6	2	EA	Locking Solid Metal Cover and Frame For CB(3110)	$400.00	$800.00	2.20%
7	540	LF	Corrugated Polyethylene Storm Sewer Pipe 24"	$40.00	$21,600.00	59.34%
8	1	EA	Catch Basin Type 2 - 48-inch Diam. With Bird Cage	$3,200.00	$3,200.00	8.79%
9	1	EA	Catch Basin Type 2 - 48-inch Diam.(3105)	$3,000.00	$3,000.00	8.24%
10	1	EA	Connect to drainage structure	$2,000.00	$2,000.00	5.49%
				Subtotal =	**$36,400**	100.00%

Contingency	30.0%	$10,920
Sales Tax	9.5%	$3,458
Planning Level Construction Cost =		**$50,800**
Property Acquisition		$0.00
Environmental Permitting and Documentation	10.0%	$5,080
Surveying	8.2%	$4,144
Administration	5.0%	$2,540
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$15,240
	TOTAL =	**$78,000**

ASSUMPTIONS:
Mobilization equals approximately 7-percent of Subtotal
Restoration equals approximately 2-percent of Subtotal
Traffic equals approximately 3-percent of Subtotal
Pipe size and length is estimated only
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($500 minimum)
Estimate does not include obtaining land or easements



CIP #2B: 228th Ave SE

Solution for Further Analysis and Design:

- Replace current overflow system with enclosed 24" (or match existing) system to convey within ROW to creek at SE 4th St and 228th Ave SE.
- Survey tree and utility locations to determine pipe layout.

Field Survey: Needed.

Road Modifications: Not needed

Downstream Impacts: Not likely since post-improvement volume discharge to stream will equal pre-improvement discharge.

Hydrologic/Hydraulic Modeling: Not Needed

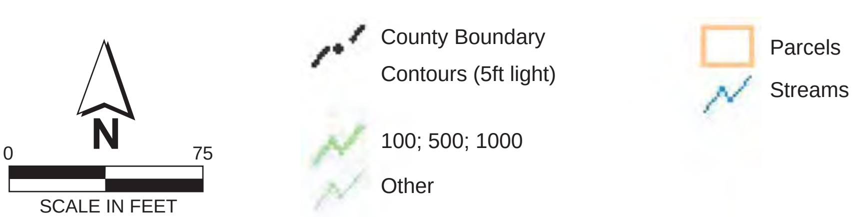
Geotechnical: Not needed

Concept-level Opinion of Cost (2010): $78,000

Capital improvement project

Parametrix 558-3847-002/02(05) 6/10 (B)

Source: King County iMAP - Stormwater (http://www.metrokc.gov/GIS/iMAP)



Capital Improvement Project
228th Ave SE

Inglewood Basin Plan
Project Description

Project Number:	CIP-3
Project Name:	NE 2nd Avenue Culvert Replacement
Description:	Replace damaged culverts at NE 2nd Avenue driveway
Purpose:	Minimize potential road flooding.
Project Benefits:	Better conveyance, less impacts to homeowners.
Assumptions:	City maintenance staff will construct project.
Estimated Cost:	$40,000
Project Partners:	None
Priority:	Medium

CITY OF SAMMAMISH
CIP IMPROVEMENTS
Preliminary Opinion of Probable Cost

Draft

CIP #: 3
Project Name: NE 2nd Drainage Improvement
Prepared By: Craig Buitrago
Checked By:

PROJECT DESCRIPTION: Remove three existing culverts beneath the driveway at NE 2nd St and 223rd Place. Install a precast concrete box culvert with stream bed. Replace the driveway.

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount	Percent of Construction Cost	
1	1	LS	Mobilization	$1,200.00	$1,200	6.67%	
2	1	LS	Traffic Control	$500.00	$500	2.78%	
3	1	LS	Restoration	$300.00	$300	1.67%	
4	1	LS	Erosion/Sedimentation Control	$500.00	$500	2.78%	
5	25	LF	CL. II RIENF. CONC. CULV. PIPE 48 IN.	$200.00	$5,000.00	27.78%	WDOT Unit Bid analysis
6	6	TON	Streambed Cobbles	$30.00	$180.00	1.00%	Back up Calcs, WDOT Unit Bid analysis
7	195	CY	Structure Excavation Class B Incl Haul	$50.00	$9,750.00	54.17%	Back up Calcs, WDOT Unit Bid analysis
8	19	TON	Crushed Surfacing Base Coarse	$30.00	$570.00	3.17%	Back up Calcs, WDOT Unit Bid analysis
				Subtotal =	**$18,000**	100.00%	

Contingency	30.0%	$5,400
Sales Tax	9.5%	$1,710
Planning Level Construction Cost =		**$25,100**
Property Acquisition		$0.00
Environmental Permitting and Documentation	10.0%	$2,510
Surveying	14.0%	$3,525
Administration	5.0%	$1,255
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$7,530
	TOTAL =	**$40,000**

ASSUMPTIONS:
Mobilization equals approximately 7-percent of Subtotal
Restoration equals approximately 2-percent of Subtotal
Traffic equals approximately 3-percent of Subtotal
Pipe size and length is estimated only
Pipe will be partially buried and have open streambed
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($500 minimum)
Estimate does not include obtaining land or easements
Estimate assumes streambed will be use only cobbles
Estimate assumes driveway will be restored back to crushed surfacing base coarse; not upgraded to pavement

CIP #3: NE 2nd Street Driveway Culvert

Solution for Further Analysis and Design:

- Remove 3 existing culverts
- Install new culvert
  - There are two culvert options: 1) partially buried 48" culvert, or 2) 4' x 4' box culvert
  - Both options have natural streambed gravel
- Restore driveway

Field Survey: Needed.

Road Modifications: Driveway will be restored to existing conditions.

Downstream Impacts: Not likely. New culvert sized to convey the 100-yr design storm.

Hydrologic/Hydraulic Modeling: Needed. Only preliminary modeling completed.

Geotechnical: Not likely if road is not modified.

Concept-level Opinion of Cost (2010): $40,000 or $54,000

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Source: King County iMAP - Stormwater (http://www.metrokc.gov/GIS/iMAP)

N

0 130

SCALE IN FEET

County Boundary
Contours (5ft light)
100; 500; 1000
Other
Local Street
Streams
Parcels

Capital Improvement Project
NE 2nd Street

Inglewood Basin Plan
Project Description

Project Number:	Ed-1
Project Name:	Conduct Wetland Tours
Description:	Organize and invite residents to participate in 1/2 day walking tours of Sammamish wetlands to learn more about wetland functions, and aquatic and terrestrial life in the wetlands.
Purpose:	Better stewardship through better understanding.
Project Benefits:	Support for wetland preservation.
Assumptions:	City or volunteer wetland scientists/ecologists would lead the tours.
Estimated Cost:	$10,000
Project Partners:	Audubon Society, Community Groups, Sammamish Parks Department, Private Citizens
Priority:	Low

Inglewood Basin Plan
Project Description

Project Number:	Enh-1
Project Name:	Rehabilitation of Wetland 1509 and its buffer
Description:	Re-establish and rehabilitate a portion of Wetland 1509 and its buffer
Purpose:	Re-establish and rehabilitate a portion of the Wetland 1509 and its buffer from pasture/lawn to functional habitat.
Project Benefits:	In many areas the buffer of Wetland 1509 has been developed. Re-establishment and rehabilitation of the buffer would help protect the wetland.
Assumptions:	Cooperation of landowners.
Estimated Cost:	$164,000
Project Partners:	Sammamish Parks Department, conservancy groups, and private citizens.
Priority:	High

CITY OF SAMMAMISH
CIP IMPROVEMENTS
Preliminary Opinion of Probable Cost

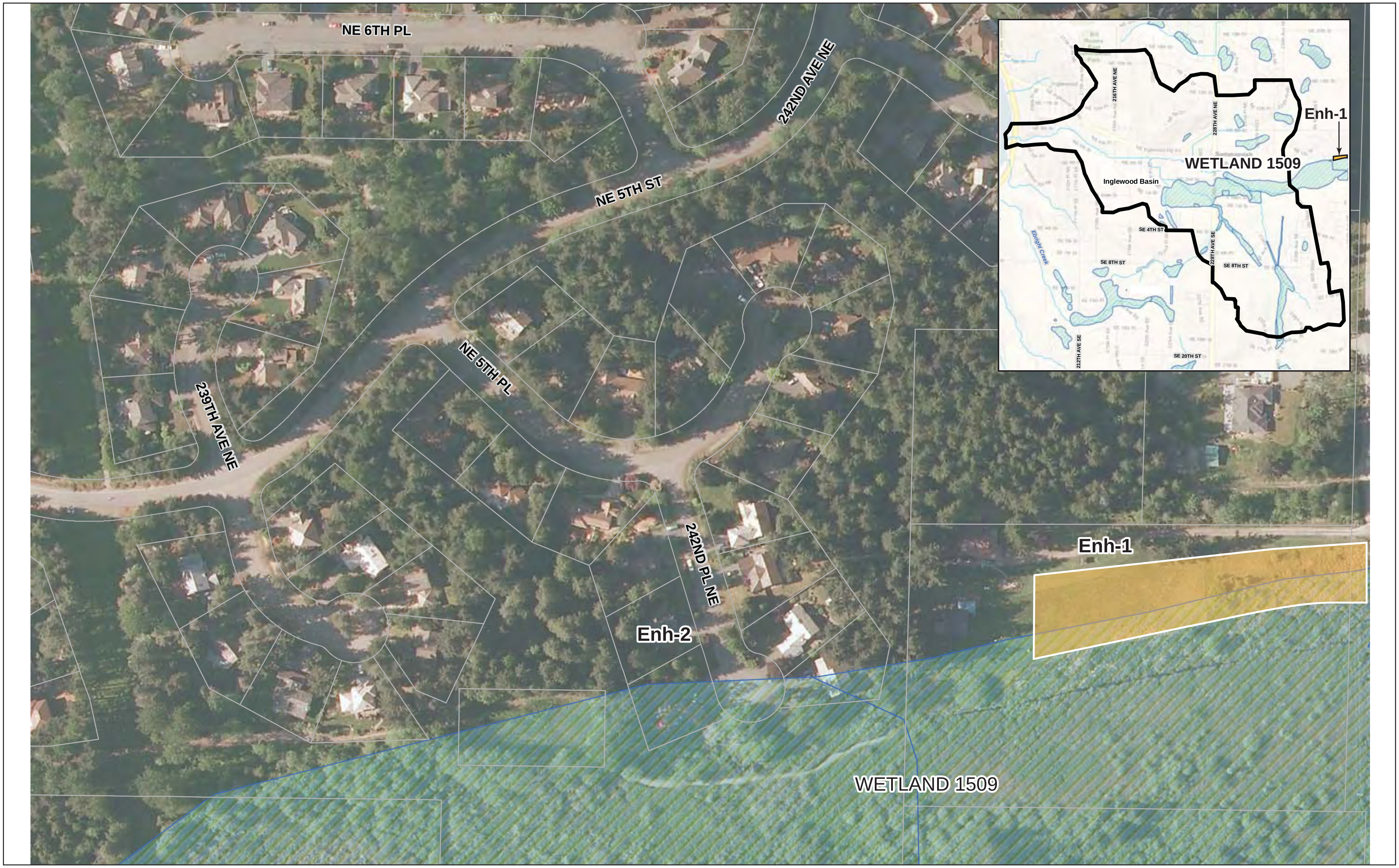
CIP #: Enh-1
Project Name: Rehabilitate Wetland 1509 and its buffer
Prepared By: Claire Hoffman

Draft

Item No.	Description		Amount	Percent of Construction Cost
1	Wetland Delineation		$2,000	2.09%
2	Surveying		$3,000	3.14%
3	Critical Areas Report		$5,000	5.24%
4	Mitigation Plan		$3,500	3.66%
5	Plant Materials (installed)		$73,000	76.44%
6	Fence and signs		$3,000	3.14%
7	Site preparation and grading		$6,000	6.28%
	Subtotal =		**$95,500**	100.00%
	Contingency	30.0%	$28,650	
	Sales Tax	9.5%	$9,073	
	Planning Level Construction Cost =		**$133,200**	
	Environmental Permitting and Documentation	10.0%	$13,320	
	Administration	5.0%	$6,660	
	TOTAL =		**$153,000**	

ASSUMPTIONS:
Wetland delineation is one 10 hour field day for two biologists
Fencing is for 300 linear feet
Plant materials includes 5500 plants as well as materials needed for planting for an area of 100,000 square feet
Estimate does not include habitat structures
Estimate does not include obtaining land or easements
Estimate does not include construction and post construction monitoring
Estimate includes 30 percent for contingency

Enh-1 PROJECT DESCRIPTION: Re-establish and rehabilitate portion of Wetland 1509 and its buffer.



Parametrix 558-3847-002/01(07) 6/10 (B)

N

0 200

SCALE IN FEET

Mitigation Opportunities

Wetland

Figure Enh(a)
Inglewood Sub-Basin
Mitigation Opportunities