City of Sammamish
Inglewood Basin Plan

Prepared for

City of Sammamish Washington

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Executive Summary

This basin plan describes the condition of the Inglewood Basin, in the City of Sammamish, and recommends solutions to address the identified issues. Concerns were identified for flooding, water quality, and habitat within the basin. In general, these problems are relatively minor.

The Inglewood Basin encompasses approximately 1,640 acres (2.6 square miles) of suburban land in the City of Sammamish. George Davis Creek is the drainage course in the basin and originates in a wetland area on the Sammamish Plateau, flows through a relatively flat channel for several miles, then drops about 300 feet in less than a mile to Lake Sammamish.

Hydraulic modeling of the basin revealed a unique characteristic—subsurface flow through glacial outwash deposits in the central portion of the basin. This outwash rapidly infiltrates flow and has a beneficial effect on the downstream reach, because it produces a hydrologic response similar to what could be obtained by 7,000 acre-feet of detention. This basin plan recommends preserving this outwash area as a natural resource.

No flooding problems were identified in the basin and modeling for future conditions shows that no flooding is anticipated under full build-out as long as infiltration to the outwash deposits continues.

George Davis Creek was listed on the Washington State Department of Ecology's (Ecology) 303(d) list for impaired water bodies because of excessive levels of fecal coliform bacteria. The water quality standards for Washington were changed in 2004. Under the new standards, George Davis Creek may no longer qualify for the 303(d) list. The City should initiate discussion with Ecology to have George Davis Creek removed from the 303(d) list.

The mouth of George Davis Creek is blocked to fish passage by a series of culverts that pass under one waterfront home and under adjacent residential properties, a private access road, and East Lake Sammamish Parkway. Daylighting the creek and constructing fish passable culverts would restore fish use to the creek.

This basin plan recommends only one capital improvement project—making the mouth of George Davis Creek fish passable. All other recommendations are programmatic in nature and focus on protecting the unique outwash areas in the basin, encouraging public education, initiating studies to fill information gaps, and encouraging actions to improve water quality.

CHAPTER

1 Introduction

1.1 Basin Planning Program Description

This basin plan provides a surface water management plan for the Inglewood Basin in the City of Sammamish (the City). Inglewood Basin is tributary to Lake Sammamish. Figure 1-1 illustrates the basin and its vicinity.

This basin plan documents existing conditions, including existing and future land use, constructed and natural drainage systems, stream flow characteristics, associated wetlands, and sensitive areas. The plan identifies water quality needs, and stream segments and wetlands where fish and other aquatic habitat have been impacted or are threatened. In identifying problems and potential solutions, drainage/flooding, water quality, and stream habitat were reviewed. The final basin plan presents one capital improvement project as well as several regulatory and programmatic measures.

1.1.1 Report Organization

This basin plan is organized by:

- **Executive Summa**ry
- **Part 1—Characterization**

  1. Introduction
  2. Existing programs and information
  3. Stakeholder involvement
  4. Current conditions
  5. Identification of problems

- **Part 2—Basin Plan Analysis**

  6. Flooding Analysis
  7. Water Quality Problems
  8. Habitat Degradation
  9. Basin Plan Recommendations

Figure 1-1: Vicinity Map

Chapter 1 describes the basin planning program, study area, statement of purpose, goals, and objectives. Chapter 2 presents the relevant policies and regulations, and highlights other related studies and reports. Chapter 3 describes the stakeholders involved in developing the basin plan and their respective roles and responsibilities. Chapter 4 summarizes Inglewood Basin's current conditions, including its topography, climate, land use, soils, natural and constructed drainage system, aquatic and riparian habitats, uplands and wetlands habitats, and water quality. Chapter 5 identifies known flooding, water quality, and habitat problems and issues within the basin. Chapters 6 through 8 quantitatively and qualitatively characterize existing and predicted problems. Chapter 9 identifies and evaluates alternatives for solving those problems.

1.1.2 Study Area

The Inglewood Basin is a subbasin within Water Resource Inventory Area (WRIA) 8 that drains to Lake Sammamish from the plateau east of the lake. This basin covers over 2.6 square miles and lies entirely within the Sammamish city limits. Basin boundaries extend roughly from NE 16th Street to the north, 240th Avenue NE to the east, SE 18th Street to the south, and Lake Sammamish to the west. The west side of the basin narrows to about a half mile width where a steep ravine concentrates runoff between the edge of the plateau and Lake Sammamish.

Numerous wetlands on the plateau form the headwaters for several tributaries that converge to become George Davis Creek (also known as Inglewood Creek or Eden Creek). The main stem of the creek descends a steep ravine where the plateau drops off into the trough containing Lake Sammamish. Porous soils at the edge of the plateau convey the majority of flow beneath the ground surface. Base flow emerges as surface flow roughly halfway down the ravine and becomes a perennial flowing stream beyond this point.

1.2 Statement of Purpose

This basin plan intends to create a comprehensive and consistent approach for reducing flood damage, improving wildlife habitat and assuring water quality throughout the City by updating a portion of the East Lake Sammamish Basin and Non-Point Action Plan (King County Surface Water Management 1994). In addition, this plan characterizes the Inglewood Basin, provides the basis for further data development, and identifies surface water management improvement projects.

1.3 Goals, Objectives, and Strategies

The general goals and objectives for City of Sammamish basin plans are presented in table 1-1 to provide direction and consistency between basin plans. They focus on protecting hydrology, water quality, and habitat as required by federal, state and local laws. The goals and objectives form the base evaluation criteria for selection of recommended facilities, policies, and surface water management program modifications from among the various alternatives.

Table 1-1
City of Sammamish Basin Planning Goals

Goal	Objectives
Reduce flood hazards	Incidents of property loss and repeat damage are reduced. Incidents of roadway flooding are reduced. Streams will not be adversely impacted by flood events. New development is located outside of flood-prone area.
Improve fish & wildlife habitat	Number of stream miles available for wild, native fish populations is increased. Population numbers of species listed as endangered or threatened under the Federal Endangered Species Act (ESA) are maintained or increased. Quality and quantity of available wetland, riparian, and upland habitat is improved.
Improve water quality	State Surface Water Quality Standards (WAC 173-201a) are met or exceeded. Number of impaired (303d listed) water bodies is reduced. The City of Sammamish is in compliance with its NPDES permit for stormwater by meeting permit terms and conditions to the maximum extent practicable. Risk of groundwater contamination is reduced. Rates of erosion are reduced.
Influence location & methods for new development	New development in flood-prone, riparian, or significant habitat areas is prohibited. Hydrologically significant natural drainage features are protected. Low Impact Development techniques are widely used. Effective BMPs are identified and widely used.

Source: *Framework Document for Basin Plans,* Pierce County Public Works & Utilities, Water Programs

CHAPTER

2 Existing Programs and Information

2.1 Programs, Policies, and Regulations

Numerous federal, state and city regulations, laws, policies, ordinances, and programs affect how surface water is managed in the City of Sammamish. This chapter describes those that are pertinent to the Inglewood Basin.

2.1.1 Federal Programs

Clean Water Act

The Clean Water Act (CWA), enacted in 1972, establishes a framework for water quality management in the United States (U.S.). The U.S. Environmental Protection Agency (EPA) delegated responsibility for implementation of many of the CWA requirements to the Washington State Department of Ecology (Ecology). Several provisions of the CWA were considered and integrated into this basin planning program. These provisions are described below.

Section 402 National Pollutant Discharge Elimination System Stormwater Permits

As part of the 1987 amendments to the CWA, Phase 1 National Pollutant Discharge Elimination System (NPDES) permits were required for stormwater discharges from cities and counties with populations of 100,000 or more that are served by separate storm sewer systems. In Phase 2, communities with populations of at least 10,000 will also be required to obtain permits. All point sources must comply with the City's NPDES permit; however, Ecology has not identified any point sources in the Inglewood Basin.

Section 303(d) List and Total Maximum Daily Loads

Section 303(a, b, and c) of the CWA requires that individual states establish standards to protect the quality of the waters of the U.S. Ecology has classified all major bodies of water in Washington based on their current or potential beneficial uses and has established a set of water quality standards for each class. Section 303(d) of the CWA requires Ecology to prepare a list of water bodies that are not meeting, or will not meet, water quality standards after application of the required technology-based effluent limits. Ecology submitted its candidate Section 303(d) list for 1998 to EPA in June 1998. George Davis Creek, the main stem of Inglewood Basin, is listed on the 303(d) list for elevated fecal coliform levels.

If a water body is out of compliance with standards for a particular pollutant, the CWA requires that a total maximum daily load (TMDL) of the pollutant be calculated. The TMDL is the maximum pollutant load that can be imposed on the water body without violating the water quality standard for the pollutant. Effluent limits for all pollutant sources discharging to the water body are adjusted downward until the TMDL can be met. If a TMDL has been calculated and the stormwater management program has been amended prior to commencement of basin planning, then the basin plan must be consistent with the stormwater management program. If a TMDL has been calculated but the stormwater management program has not yet been amended, then the basin planning process will serve as a vehicle to develop the necessary revisions. No TMDL limits have been set for George Davis Creek at the time this basin plan was prepared.

Section 404 Wetland Fill Permits

Placement of fill in the waters of the U.S. is regulated under Section 404 of the CWA. Section 404 defines waters of the U.S. as wetlands adjacent to streams with average annual flow greater than 5 cubic feet per second (cfs), as well as isolated wetlands with an area greater than 1 acre. The average annual flow for George Davis Creek is less than 5 cfs. Section 404 is administered by the U.S. Army Corps of Engineers (Corps); the Corps' Seattle District issues Section 404 permits in the City of Sammamish. Projects that involve filling small areas of wetlands may be permitted under one of several nationwide general permits. An individual permit must be obtained for projects that involve filling more than 5 acres of wetlands. Because the goal of Section 404 is to avoid any net loss of wetlands, permits usually require compensatory mitigation for any loss of wetlands.

Endangered Species Act

The Endangered Species Act (ESA) is intended to conserve endangered and threatened species. It directs the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) to promulgate a list of endangered and threatened species and designate critical habitat for these species. Two species have the greatest potential to affect surface water management in the City: chinook salmon, which was listed as threatened in March 1999, and bull trout, which was listed as threatened in October 1999. NMFS has indicated that additional salmonid species may be listed in the next few years.

If a proposed action is federally funded or requires a permit from a federal agency, and if it could have an adverse effect on a listed species, then Section 7 of ESA requires the involved federal agency to consult with USFWS or NMFS. After consultation, USFWS or NMFS will issue a biological opinion regarding the effects of the action. If USFWS or NFMS finds that the action could jeopardize the continued existence of the species, the action will not be permitted. If USFWS or NMFS finds that the continued existence of the species is not jeopardized, then one of the agencies will issue an Incidental Take Statement and allow the action to proceed.

Section 9 of ESA prohibits "taking" of endangered species. To "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The regulation further explains that "harm" may include "significant habitat modification where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering."

Section 4(d) of ESA requires USFWS and NMFS to adopt regulations as necessary to conserve the species listed as threatened. USFWS typically applies the Section 9 "take" prohibitions directly to threatened species. NMFS typically promulgates "4(d) rules" that identify specific activities that can be conducted without constituting an unlawful take of the threatened species.

The general implications of the salmonid listings clearly indicate that the basin planning process should include measures and improvements to protect existing salmon habitat and enhance degraded habitat. In addition, several elements of the Tri-County program rely on knowledge of basin conditions derived from Water Resources Inventory Area (WRIA) planning. Much of this knowledge, with regard to stormwater, wildlife habitat, and land use effects on streams, will be obtained during the basin planning process and will then be used in the larger WRIA plans.

Currently, no threatened, endangered, or candidate species use George Davis Creek or are present in the Inglewood Basin.

National Flood Insurance Program

In 1968, Congress created the National Flood Insurance Program (NFIP). This program makes flood insurance available to communities that agree to adopt and enforce floodplain ordinances designed to reduce flood damage. The Federal Emergency Management Agency (FEMA) administers the NFIP.

The City's adopted floodplain regulations restrict construction in the 100-year floodplain. The regulations prohibit construction in the floodway (the primary route for flood flows) and require structures elsewhere in the floodplain to be elevated above the 100-year flood water level.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) of 1974 transferred responsibility for regulating drinking water to EPA and called on that agency to protect the quality of the nation's drinking water supplies. EPA has set maximum contaminant levels (MCLs) in drinking water for more than 100 substances. Section 1424(e) of the SDWA established the Sole Source Aquifer Program. EPA was authorized to identify aquifers that are the sole or principal source of drinking water for an area. The program also calls for EPA to review all federally funded projects planned for the area. Based on the review, the EPA administrator may withhold commitment of federal financial assistance for projects determined to be potential threats to the aquifer.

The SDWA was amended in 1986. The new provision (Section 1428) required each individual state to develop a wellhead protection program. A wellhead protection program seeks to protect the quality of groundwater bodies used for water supply so that water arrives at the wellhead uncontaminated. In Washington, the Department of Health was designated as the lead agency for wellhead protection program development and administration, but responsibility was delegated to the counties. Federal regulations require all public water systems using groundwater as their source to implement a wellhead protection program. In Washington, local programs must include these elements:

- Delineated wellhead protection area for each well, wellfield, or spring
- Inventory within the wellhead protection area of all potential sources of groundwater contamination

- Management plan to reduce the likelihood that potential contaminant sources will pollute the drinking water supply
- Contingency plans for providing alternate sources of drinking water in the event that contamination does occur
- Public participation while the program is developing

The Sammamish Plateau Water and Sewer District supplies drinking water for the City. Though the district is not currently (2004) connected to the Regional Water System (Seattle's system) and presently obtains its water from a series of groundwater wells, the District is in the process of connecting to the Seattle system. Wellhead protection areas within the basin include areas around wells 4 and 11.2 and cover an area of almost two square miles in the center of the basin.

2.1.2 State Laws and Regulations

A number of state laws and regulations affect basin plans. The most relevant ones are described below.

Water Quality Standards

As described in Section 2.1.1, Ecology has classified Washington's surface waters based on their current and potential beneficial uses.

Under WAC 173-200, Washington has also established groundwater quality standards designed to protect existing and future beneficial uses of groundwater by reducing or eliminating discharge of contaminants. WAC 173-200 defines water quality standards for all groundwater in the state. One of the more controversial components of this regulation is the anti-degradation policy, which prohibits degradation of any groundwater that currently has better water quality than its designated standards. WAC 173-200 also allows for designation of special groundwater protection areas based on unique characteristics (e.g., recharge areas, wellhead protection areas, or sole source aquifers).

WAC 173-201A and 173-200 affect the discharge of stormwater to surface water and groundwater, respectively. Consequently, any stormwater planning effort must consider these regulations when developing specific capital improvement projects, such as a large regional infiltration basin that might affect groundwater quality.

Growth Management Act Requirements

The Washington State Legislature enacted the Growth Management Act (GMA) in 1990, and amended it in 1991 and 1993, to better manage growth in some of the state's fastest growing areas. The Washington State Department of Community, Trade and Economic Development administers the GMA. The GMA specifies a comprehensive framework for counties and cities/towns to follow in managing growth and in coordinating land use development, with provision of an infrastructure to support development. This framework includes these actions:

- Designation of critical areas

- Designation of conservation and natural resource lands
- Adoption of countywide planning policies that provide a general framework for regional planning
- Adoption of urban growth area (UGA) boundaries and development regulations
- Adoption of county and city comprehensive plans, including capital facilities elements and implementing regulations

Decisions that the City makes with respect to growth management planning will affect the basin planning process. For instance, land use decisions will drive stormwater management infrastructure needs in a given area, and critical area designations may restrict siting of stormwater facilities. Conversely, surface water management decisions could limit land use options if individual basin plans identify stream reaches that must be protected from the hydrologic impacts of new development.

State Environmental Policy Act

The State Environmental Policy Act (SEPA) is intended to ensure that environmental values are considered (in addition to technical and economic considerations) by state and local government officials when making decisions. The SEPA process starts when a public agency proposes to take an official action, such as adopting a master drainage plan or issuing a permit for a project. Various documents then must be prepared describing the probable environmental impacts of the action.

Basin planning documents are internal guidance documents rather than proposals for action and, consequently, are not subject to SEPA requirements. The individual basin plans, however, will be subject to SEPA requirements. The documents that are needed for compliance with SEPA will be prepared concurrently with the basin plans. Because the basin plans are expected to produce net environmental benefits, compliance with SEPA is likely to be straightforward.

Shoreline Management Act

The Washington State Legislature passed the Shoreline Management Act (SMA) in 1971; the SMA was adopted by the public in a 1972 referendum. The goal of the SMA is to “prevent the inherent harm in an uncoordinated and piecemeal development of the state’s shorelines.”

The SMA divides authority for compliance between local and state governments. Cities and counties are the primary regulators, but Ecology has the authority to review local programs and to make permit decisions. Under SMA, each city and county adopts a shoreline master program based on state guidelines but tailored to the needs of the community. Master programs provide policies and regulations addressing shoreline use and protection, as well as a permit system for administering the program. The SMA applies to:

- All marine waters
- Streams with a mean annual flow greater than 20 cubic feet per second
- Lakes 20 acres or larger

- Upland areas (called "shorelands") 200 feet landward from the edge of these waters
- Biological wetlands, river deltas, some or all of the 100-year floodplain, including all wetlands within the entire floodplain, when they are associated with one of the above

Any proposed action within 200 feet of Lake Sammamish would fall under this jurisdiction.

State Hydraulic Code

The Washington State Hydraulic Code (RCW 75.20.100-140) regulates any activity affecting the state's fresh waters and salt waters to preserve fish and wildlife habitats. The Hydraulic Code is administered by the Washington State Department of Fish and Wildlife (WDFW), which requires any person, organization, or government agency whose construction project lies within the ordinary high water line of all marine waters and fresh waters of the state, to obtain an Hydraulic Project Approval (HPA) Permit. WDFW uses the HPA permitting process to attach conditions that help ensure construction projects are managed, sequenced, and conducted to minimize impacts on fish and shellfish habitat.

Many potential solutions developed in future basin plans could lie within or near state waters. Consequently, the ability to obtain project permits will need to be considered in evaluating project recommendations.

Watershed Management Act

The Washington State Legislature passed the Watershed Management Act (HB 2514) in 1998 to provide a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water resource-related problems in each of the state's 62 WRIAs.

The goals of these watershed plans are to assess the status of water resources in the WRIA and to determine how to balance the competing demands for water within the WRIA, including ensuring that there is enough water in the streams for fish. As an option, watershed plans may also recommend management improvements for habitat and water quality and establish or revise required in-stream flows. The planning process includes collection of biological and physical data on the watersheds and creation of organizations to facilitate water resource management within the WRIAs.

WAC Chapter 400-12 establishes criteria and procedures for ranking watersheds in Washington and for developing and implementing action plans for watersheds that need corrective and/or preventive actions. The purpose of WAC 400-12 is to reduce pollutant loading from nonpoint sources, prevent new sources from being created, enhance water quality, and protect beneficial uses. The planning process encourages collaborative problem solving among local, state, tribal, and federal interests. It relies on voluntary actions, local ordinances, and state and federal laws, regulations, and programs.

2.1.3 City Ordinances, Policies, and Programs

City of Sammamish ordinance 099-17 adopts King County Title 9 - Surface Water Management as an interim regulation. This title outlines the City's surface water runoff policies (including technical requirements for development), describes the surface water management program, and water quality measures to protect natural resources.

The City has also produced a Stormwater Management Comprehensive Plan. This plan was adopted in 2001 and details the City's various drainage basins, evaluates modeling needs, describes general environmental and water quality problems, recommends policies related to surface water management, recommends a maintenance program, proposes a capital improvement program for 2001—2006, and contains a utility financial plan.

2.2 Review of Existing Reports and Plans

These reports on available resources were used in the investigation of Inglewood Basin.

- East Lake Sammamish Basin and Non-Point Action Plan (King County Surface Water Management, 1994)
- East Lake Sammamish Basin Conditions Report-Preliminary Analysis (King County Surface Water Management Division, 1990)
- Lake Sammamish Water Quality Management Plan (Entranco, 1996)
- City of Sammamish Comprehensive Stormwater Management Plan (CH2M HILL, 2001)
- Surface Water Design Manual (King County Department of Natural Resources, 1998)
- Validation of a Numerical Modeling Method for Simulating Rainfall Runoff Relations for Headwater Basins in Western King and Snohomish Counties (R.S. Dinicola/USGS)

CHAPTER

3 Stakeholders Involvement

The City of Sammamish is responsible for the basin planning process, and is therefore a primary stakeholder responsible for initiating, coordinating, and responding to other stakeholder groups and individuals. Some of the other stakeholder groups and individuals included within this basin are the Lake Sammamish Management Committee, Washington State Department of Fish and Wildlife (WDFW), Washington State Department of Transportation (WSDOT), Muckleshoot and Snoqualmie Indian Tribes, Washington State Department of Natural Resources (DNR), and private citizens who reside within the Inglewood Basin.

Basin residents have been encouraged to participate in the basin planning process from the beginning. An initial public meeting was held (November 5th, 2003) to inform residents about the City's intent to produce the basin plan and to solicit information from residents about problems that may be occurring with flooding, water quality, or habitat issues. A second public meeting was held (April 22nd, 2004) to update citizens on the issues identified while characterizing the basin and to provide the opportunity for further comment before formal recommendations were developed. A third public meeting (August 24th, 2004) was held for comments on the draft plan.

Comments on the plan will also be solicited from the Lake Sammamish Management Committee, WDFW, WSDOT, Muckleshoot and Snoqualmie Indian Tribes, and DNR.

CHAPTER

4 Current Conditions

4.1 Topography, Land Forms, and Planning Units

4.1.1 Topography and Land Forms

The Inglewood Basin occupies approximately 2.6 square miles of the northern portion of the East Lake Sammamish Basin. Glacial sediments dominate the geology of the East Lake Sammamish Plateau. The stratigraphy in this area includes till on the surface overlaying advance outwash sands, gravels, silt, and clay deposits. Discontinuous silt and clay lenses occur sporadically throughout the outwash sands. Peat and organic deposits are found in depressions mostly in the upper portions of the Sammamish Basin in the Inglewood area. Soils and colluvium cover the glacial sediments to a thickness that varies from less than 1 foot on steep hillslopes to greater than 3 feet in the low-gradient areas.

The Inglewood Basin has topography typical for Puget Lowland streams with specific features that are associated with the glacial trough of Lake Sammamish. The east end of the basin is on the Sammamish Plateau, which is composed of gently undulating land with numerous depressions filled by lakes, wetlands, and bogs. The edges of the watershed range in elevation from 510 feet[1] to as high as 615 feet at the north end of the basin. George Davis Creek has formed an incised valley that is relatively flat across the center of the basin and supports large wetlands. This valley is predominately recessional outwash. The basin drains west to Lake Sammamish through a steep ravine where the elevation of the valley floor drops from roughly 300 feet to 35 feet. Figure 4-1 illustrates the topographic features of the Inglewood Basin.

George Davis Creek (tributary 0144) is the main channel in the Inglewood Basin and is also known as Inglewood Creek or Eden Creek. The creek has one significant tributary, that drains the south side of the basin, and at least four other minor tributaries that contribute flow from other parts of the basin.

Urbanization is occurring rapidly within the Inglewood Basin as multi-acre horse pastures and hobby farms are being converted to clusters of single-family residential housing and schools. With the increase in housing, manmade conveyance for stormwater runoff has increased correspondingly and has contributed to an increase in hydrologic changes within George Davis Creek.

4.1.2 Subbasins

The basin was divided into 13 subbasins for planning and modeling purposes. Subbasins from previous delineations were refined based on field knowledge of city staff and recent changes in development patterns. Figure 4-2 shows the spatial arrangement of the 13 subbasins.

[1] Elevations are recorded as feet from the National Geodetic Vertical Datum created in 1929 (NGVD29), which is also known as "mean sea level."

Figure 4-1: Topography

Figure 4-2: Subbasins

4.2 Climate

Climate in the Inglewood Basin is typical of the Pacific Northwest region. Temperatures are moderated by proximity to Puget Sound and the Pacific Ocean, resulting in mild winters and warm, but not hot, summers. Average annual precipitation (mostly as rain) is 39.14 inches (http://splash.metrokc.gov/wlr/waterres/lakes/SAMM.htm) with 75 percent falling between October and March. Periods of maximum runoff correspond closely with periods of maximum rainfall.

4.3 Land Use

4.3.1 Existing Land Use

Development Patterns

The Inglewood Basin has seen rapid growth from a primarily forested farming community to a developed residential community. Most of the basin is now covered by varying densities of residential development with one central commercial area near the corner of 228th Avenue SE and Inglewood Hills Road. Some upper portions of the basin still have large open tracts of land that are either grass or forest. The distribution of land cover in this basin is patchy with clusters of denser development surrounded by more open areas. Figure 4-3 illustrates this existing land cover.

Impervious Surface Analysis

The basin has 244 acres of impervious surface area, which comprises about 15% of the basin area. While not excessive, this percentage of impervious area is in the range known to have impacts on streams and wetlands. Table 4-1 breaks down impervious area by subbasin.

Table 4-1
Impervious Surface Area by Subbasin, Existing Conditions

Subbasin	Subbasin Area (acres)	Impervious Area (acres)	Percent Impervious
I1	203.3	20.0	9.8 %
I2	250.0	27.0	10.8 %
I3	68.2	6.3	9.2 %
I3A	178.0	12.0	6.7 %
I4	13.1	0.8	6.1 %
I4A	374.6	96.3	25.7 %
I5	82.3	24.7	30.0 %
I5A	70.7	1.0	1.4 %
I5B	54.4	10.7	19.7 %
I6	62.5	2.3	3.7 %
I6A	21.3	4.9	23.0 %
I7	243.8	34.0	13.9 %
I7A	18.0	4.1	22.8 %

Figure 4-3: Existing Land Use

4.3.2 Future Land Use

Development Patterns

The basin's current zoning was used to predict future land use. In many of the subbasins, the current city zoning is already built out or close to built out indicating that future growth will be limited. The current zoning is set up to cluster the densest development around the commercial center and spread residential areas throughout the rest of the basin. Figure 4-4 depicts this pattern.

Future Percent Impervious Area

Fully built out, the basin would have almost 400 acres of impervious surface area, which is roughly 24% of the basin area. Table 4-2 breaks down future impervious area by subbasin.

Table 4-2
Impervious Surface Area by Subbasin, Future (Predicted) Conditions

Subbasin	Subbasin Area (acres)	Impervious Area (acres)	Percent Impervious
I1	203.3	37.8	18.6 %
I2	250.0	52.7	21.1 %
I3	68.2	13.4	19.6 %
I3A	178.0	34.0	19.1 %
I4	13.1	1.8	13.7 %
I4A	374.6	131.8	35.2 %
I5	82.3	34.3	41.7 %
I5A	70.7	11.1	15.7 %
I5B	54.4	12.5	23.0 %
I6	62.5	10.7	17.1 %
I6A	21.3	4.9	23.0 %
I7	243.8	48.5	19.9 %
I7A	18.0	4.1	22.8 %

Figure 4-4: Zoning

4.4 Population

4.4.1 Current Population

Table 4-3 presents the current population trends for the Sammamish Plateau and the City of Sammamish. Inglewood Basin covers roughly 20 percent of the City's area and is estimated to house roughly 20 percent of the population. This gives the Inglewood Basin an estimated current population of just under 7,000 people.

Table 4-3
Sammamish Plateau/City of Sammamish Population Growth

Geographic Area	1970	1980	1990	1997	2000	2001
Sammamish Plateau	6,000	12,300	31,000	41,300	43,200	n/a
City of Sammamish	n/a	n/a	n/a	26,200	34,104	34,560
Inglewood Basin	n/a	n/a	n/a	5,240	6,820	6,912

4.4.2 Future Population

The City of Sammamish and, correspondingly the Inglewood Basin, grew 32 percent during the first four years after it incorporated in 1999. This growth rate is actually slower than that seen on the Sammamish Plateau over the last thirty years when the population more than doubled every decade. At the City's current growth rate, the Inglewood Basin population would be anticipated to rise to 9,000 people in 2010, 11,900 people in 2020, and 15,700 people in 2030. These estimates are most likely high, however, because it is likely that growth rates will continue to slow in this area as prime developable lots become built out.

4.5 Geology and Soils

4.5.1 Geology

The processes of glaciation were the predominant drivers in creating the geologic formations in the Pacific Northwest. The advance and retreat of glaciers during the last glaciation period, roughly 10,000 years ago, created a general pattern in the Puget lowlands of outwash over lain by till. Outwash was formed during a glacial advance as melt water ran out ahead of the glacier sorting stones of larger sizes and washing away fines. These soils are characteristically loose and well draining. On top of the outwash is a layer of glacial till that was formed from material compacted by the weight of the overlying glacier. Till is poorly sorted with tightly compacted clay forming a dense poorly drained layer.

Stream channels commonly erode through the till layer and into the outwash material. This is the case in the Inglewood Basin where George Davis Creek has eroded the till from the center of the basin down to the outwash below.

4.5.2 Soils

Two general soil associations are found in the Inglewood Basin: the Alderwood association and the Everett association. Alderwood soils ring the basin along its edge where the higher hills are composed of glacial till. The Everett association covers the central portion of the basin where George Davis Creek has formed a wide valley in the glacial outwash below the till layer. General descriptions of these associations are below.

Alderwood association: Moderately well drained, undulating to hilly soils that have dense, very slowly permeable glacial till at a depth of 20 to 40 inches: on uplands and terraces.

Everett association: Somewhat excessively drained, gravelly, gently undulation soils underlain by sand and gravel: on terraces.

4.6 Natural and Constructed Drainage

4.6.1 Drainage Overview

The headwaters for the main channels of George Davis Creek are wetlands in the upper basin generally east of 228th Avenue NE. Many of the wetlands connect via open channels or piped flow in some places with flow moving from east to west. West of 228th Avenue NE surface flow runs in channels; although for most of the year, these channels are dry. Because of the porous nature of the outwash soils in this area, base flow moves beneath the surface. The two main branches of George Davis Creek come together near the intersection of NE 4th Street and 219th Avenue NE. After crossing NE 6th Street, the creek descends into a forested ravine. Summer base flow emerges roughly one-half mile from the mouth where the decent of the ravine is sufficient to intersect the groundwater. At the bottom of the ravine, a series of culverts convey flows under East Lake Sammamish Parkway, under a private access road, and under a waterfront home. An overflow bypass pipe conveys excessive stormwater volumes to the north and discharges flows into Lake Sammamish at a boat launch. Figure 4-5 shows the stream network for Inglewood Basin.

4.6.2 Streamflow Characteristics

Outwash areas in the center of the basin give this creek a very unique hydrology. Water runs beneath the surface from just west of 228th Avenue NE until it reemerges downstream of NE 6th Street. This area of subsurface flow acts like detention providing approximately 7,000 acre-feet of storage. This natural detention buffers the effects of development for the downstream reaches.

Figure 4-5: Streams

During storm events, the channels have surface flow and flooding has been known to occur in some places though usually because of damaged or inadequate culvert sizes (these problem culverts have been replaced). No studies have been done to determine which storm event return period produces surface flow, so it is unknown to what extent development in the upper basin has already affected the hydrology in this area. However, it is reasonable to anticipate that surface flows will become more frequent as the basin's impervious area increases.

The City operates a streamflow gage (Gage 15G) near the mouth of George Davis Creek and a precipitation gage (Gage 18Y) near the headwaters. Flow gages have not been installed in the upper areas of the basin.

4.7 Aquatic, Riparian, and Wetland Habitat

4.7.1 Historical Fish Presence

George Davis Creek at one time 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). Currently, a fish barrier restricts migrating fish to the first few hundred feet of George Davis Creek. Several culverts comprise the fish barrier and were built to convey the stream under a lake front home and the adjacent residential property and under East Lake Sammamish Parkway. Cutthroat trout and rainbow trout have also been previously identified in George Davis Creek.

4.7.2 Streams

Available fish habitat in Inglewood Basin is limited because base flow goes subsurface roughly one-half mile from the mouth of the creek. The best fish habitat in the basin is between NE 6th Street and East Lake Sammamish Parkway where the stream runs through a narrow ravine. Although this area has high quality habitat, anadromous fish are unable to use it because of the extensive fish barrier near the mouth of the creek.

The streambed within the ravine has very loose movable substrate that varies in size from fine sand (0.5 mm) to large cobble (200 mm). The abundant bed material comes mostly from soil creep along the ravine walls and slumping that deposits soil into the creek. The unconsolidated soils of the valley walls erode easily. In several places, the stream is undercutting the toe of these hillslopes. These undercuts will eventually collapse dropping hillslope soil into the creek. This natural process could be accelerated by increased peak flow as a response to urbanization.

Large woody debris (LWD) is plentiful within the ravine with an estimated average spacing of one piece every 6 to 9 feet. The forested riparian area is mature and will continue to replenish LWD in the stream. This wood provides protective pools and diverse habitat for aquatic species and also helps to retain sediment in the channel.

In a few places within the ravine, openings in the forest canopy allow abundant sunlight to reach the stream channel. Invasive species such as Himalayan blackberry (*Rubus discolor*) grow in these areas. Water loving plants such as devil's club (*Oplopanax horridus*) and salmonberry (*Rubus chamaemorus*) are more abundant at the downstream end of the ravine where there is perennial base flow.

4.7.3 Lakes

The Inglewood Basin has only a few small lakes, most of these are small open-water sections within wetlands. The largest lake is Llama Lake, which lies in the northeast corner of the basin just north of NE 8th Street with an outlet that flows southwest through wetlands.

Lake Sammamish is the receiving waters for George Davis Creek and therefore runoff from Inglewood Basin influences the lake. Lake Sammamish is the sixth largest lake in Washington with a surface area of 4,940 acres and an overall drainage basin of 56,000 acres, of which Inglewood Basin is only a small part. The Shoreline Management Act designates the lake as a resource of state-wide significance. The lake provides migratory and rearing habitat for many salmonid species as well as being home for many other fish and wildlife species. Runoff from residential and commercial development around the lake has increased phosphorus pollutant loads in particular and degraded the water quality. Efforts are underway to curb the impacts of urbanization on Lake Sammamish. Therefore, water quality in George Davis Creek is of concern to Lake Sammamish as well.

4.7.4 Wetlands

The primary wetland in the Inglewood Basin runs east to west just north of Main Street (see Figure 4-6). This palustrine forested wetland that extends across the east basin boundary and into the Bear/Evans Creek Basin. This wetland is expanding possibly due to poor conveyance. The trees that surround this wetland have begun to die, presumably because of increased saturation of the soil. In addition, several small wetlands are scattered throughout the basin, mostly associated with the headwaters of tributaries to George Davis Creek.

4.8 Upland Habitat

4.8.1 Forestland

The basin has some large stands of trees, mostly along waterways and around wetlands. These wooded areas occur in patches throughout the basin. One of the largest remaining wooded places is in the canyon formed by the main stem of George Davis Creek as it descends to Lake Sammamish. Other remaining stands occur mostly in the southeast portion of the basin where development is still limited.

4.8.2 Grassland

Patchy areas of pasture land can be found mostly in the southeast part of the basin where some land owners still raise livestock. These areas are diminishing as development continues. As more homes are built, landscaped lawns replace the pasture grass.

4.8.3 Landscaped Areas

Most of the basin's landscaped areas are private lawns and gardens around residential homes.

Figure 4-6: Wetlands

4.9 Water Quality

Water quality is a concern in both the streams and wetlands of Inglewood Basin. Non-point sources are the primary contributors of pollutants in this basin, because this area has no regulated point sources according to Ecology. A thorough discussion of non-point pollutants can be found in the City of Sammamish Comprehensive Stormwater Plan (2001). Nonpoint sources that impact the Inglewood Basin include those from urbanization, construction, sewage, trash dumping, and livestock.

The Inglewood Basin is undergoing a transition from rural land with small hobby farms and horse pasture to moderate and high-density residential areas with more lawn and paved roadways. Currently (2004), both of these land uses coexist within the basin. This wide mixture of land uses makes water quality issues complex.

George Davis Creek was placed on Ecology's 303(d) list of polluted waters of the state because of elevated levels of fecal coliforms found in stormwater samples collected in the late 1980s and early 1990s. The East Lake Sammamish Conditions Report (King County, 1990) suggests that leaking septic or sewer systems may be the source of this pollutant. The City of Sammamish Stormwater Comprehensive Plan points to livestock in the upper basin as another potential source. Recent development in the basin has decreased the number of local hobby farms and so potentially reduced the frequency of livestock accessing the creek. Recent studies have show that another significant source of coliform bacteria can come from domestic pets and waterfowl. Genetic testing is one way that fecal coliform sources can be determined.

Also, during this same sampling period, some reaches in the creek were found to have elevated levels of total phosphorus and copper. Stormwater samples from commercial areas had elevated levels of suspended solids and heavy metals. Base flow samples did not exceed state standards for dissolved oxygen, temperature, or pH. No recent water quality samples have been collected to update the creek's water quality status.

CHAPTER

5 Identification of Problems

5.1 Problem Description

This section describes general surface water problems that have been identified within the basin, and how different information sources were used to identify problems.

5.1.1 Sources of Information for Problem Identification

This section lists information sources used to identify problems. Examples are:

- Citizen input
- Habitat field visits
- City of Sammamish Public Works staff
- *East Lake Sammamish Basin Conditions Report* (King County SWM, 1990)
- *Watershed Management Committee – Proposed East Lake Sammamish Basin and Nonpoint Action Plan* (King County SWM, 1992)
- *Lake Sammamish Water Quality Management Plan* (King County SWM, 1996)
- *City of Sammamish Surface Water Comprehensive Plan* (CH2M HILL, 2001)
- *Planning Advisory Board Recommended Draft Comprehensive Plan* (City of Sammamish, 2003)
- *Draft Supplemental EIS for the Planning Advisory Board Recommended Draft Comprehensive Plan* (City of Sammamish, 2003)

5.1.2 Methodology of Problem Identification

Problems were identified in three basic ways:

- Collecting information from past reports on the conditions in the basin.
- Field verifying these conditions to see if problems were still present.
- Listening to input from residents to find new or persistent problems.

5.2 Flooding

Previous reports describe a few areas in the basin where localized residential flooding occurred because of inadequately sized culverts. Capital improvement projects (CIPs) were implemented at these sites, and no further flooding has been reported. No additional areas of flooding were discovered during the investigation for this Basin Plan.

5.3 Water Quality Degradation

There is a lack of water quality data for George Davis Creek. Water quality samples have not been collected in George Davis Creek since the early 1990s. It was at this time that the creek was placed on Ecology's 303(d) list because of elevated levels of fecal coliform bacteria. Since that time, changes have occurred in both basin conditions and state water quality standards.

Growth in the basin has shifted land use away from widespread livestock use and toward residential housing. This reduction in livestock in the basin may have already reduced the fecal coliform problems observed in past years. New water quality testing is needed to determine if water quality has improved in recent years. If high fecal coliform levels persist, then septic systems in the basin could also be contributing to the problem.

Other water quality problems in the basin include issues typical for urban and urbanizing areas. These include elevated levels of total phosphorus and copper in the creek and elevated levels of suspended solids and heavy metals in stormwater from commercial areas.

Ecology has recently revised the state water quality standards (chapter 173-201A WAC). Water bodies are now protected according to their use with the categories of aquatic life, recreation, water supply, and miscellaneous uses. Under these standards, fecal coliforms are a concern of recreational uses particularly for swimming and boating. George Davis Creek is too small for swimming or boating. However, it discharges into Lake Sammamish that is used for both swimming and water skiing. Discussions with Ecology should be initiated to determine if George Davis Creek holds a different status under the new regulations.

5.4 Habitat Limiting Factors

5.4.1 Riparian Function

Compared to many other suburban streams George Davis Creek has a relatively intact riparian corridor. Where the stream passes through private backyards, the riparian corridor becomes very narrow, but for the most part, trees and shrubs have been maintained near the creek. The basin has no significant riparian issues.

5.4.2 Fish Passage

The main fish barrier in the basin occurs at the mouth of the creek, where flow moves through a series of culverts under a waterfront home and the adjacent property on the shore of Lake Sammamish. These culverts act as a barrier to anadromous fish that may otherwise use the stream. A stormwater overflow is located on the upstream side (east side) of East Lake Sammamish Parkway. A separate pipe routes the overflow under the roadway and north about 500 feet where flows discharge to Lake Sammamish near a private boat launch (Figure 5-1). Issues were noted at this overflow outfall because of deposition of material during large storms that degrades the quality of the beach property.

Figure 5-1: Configuration of the George Davis Creek mouth

5.4.3 Summer Low Flows

Most of the main stem of George Davis Creek passes over a highly infiltrative area of outwash. In these areas, base flow does not occur on the surface even in winter. Water reemerges from the outwash area downstream of NE 6th Street. The exact area where water reemerges depends on the season and the amount of recent rainfall. In winter, the water reemerges higher up in the basin than it does in summer. This is the natural hydrology of this creek and is not problematic.

5.4.4 Erosion and Bedload Movement

Erosion is occurring in the canyon where George Davis Creek flows downstream from NE 6th Street. This canyon has steep walls that slump frequently sending eroded material into the creek. A lot of this material is being held in the channel by copious amounts of woody debris. Some of this woody debris has been placed here intentionally; some of it has fallen naturally from the surrounding riparian area. Sediment transport down the creek is not excessive because of the high quality conditions of the channel. However, high-flow events transport sediment from the basin rapidly, and sediments have been known to be deposited around the outlet in the lake as a result. This process is natural to the creek and is only considered a problem because the deposition of sediment along the lake shore impacts waterfront homes.

CHAPTER

6 Flooding Analysis

6.1 Modeling and Analysis of Causes

An HSPF basin model was developed to determine if the basin has areas prone to flooding either now or in the future. Input for the watershed was developed by the USGS and utilized by King County as part of the 1991 East Lake Sammamish Basin Plan. This analysis modified the model input to reflect changes to the stream channel in Subbasin I3—the channel had been rerouted and enters the main stem further upstream. Subbasins I5A, I6, and I7 were subdivided to account for on-site detention associated with a recently constructed residential development. Figure 4-3 depicts the basin and subbasin boundaries used in the model. A full report on the model details can be found in Appendix A.

The HSPF model was calibrated to ensure that the hydrologic processes simulated by the model represented the conditions in the Inglewood Basin. Calibration is the process whereby the model input parameters are adjusted until simulated and recorded discharge data match to the greatest extent possible.

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 of October 2001 through May 2003. Daily evaporation data were developed from data collected at the Puyallup 2 West Experimental Station (station number 45-6803)

The geology of the watershed consists of till in the uplands with glacial outwash in the ravine that carries the stream channel (see Figure 6-1). Surface runoff and interflow produced in the upland till areas infiltrate as flows cross the outwash deposit producing a markedly attenuated runoff response from the watershed.

To account for these outwash areas, 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. The model 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 deposits.

Figure 6-1: Geology

Because the outwash deposits provide a high level of flood attenuation, future land use scenarios did not include on-site detention for new development. Flow attenuation due to on-site detention would be indistinguishable after routing flows through the outwash deposit and was therefore not included out of convenience. Regardless, on-site detention should be required in future development in the watershed to ensure that flow discharge rates reaching the outwash do not increase to the point where they overwhelm the infiltration rate of the outwash deposit. Not providing any on-site detention with new development would dramatically increase the discharge rate in George Davis Creek as surface runoff in excess of the outwash infiltration rate discharged downstream.

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

In general, peak discharge rates under future conditions had relatively small increases with a watershed average increase in discharge of 15 percent. The small increase is due to the presence of the glacial outwash deposit, which infiltrates most surface runoff produced in the till capped uplands.

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 larger sized stream gravel as the smaller gravel fraction is carried downstream.

The model shows a relatively small change in the George Davis Creek flow duration statistics for the future relative to existing conditions. 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.

6.2 Modeling Results

The presence of glacial outwash in the central part of the watershed 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 I12). Downstream, the stream intersects the groundwater table (Subbasin I1) and receives the majority of flow via groundwater discharge. The groundwater discharge also produces year round 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. Relatively small increases in runoff rates were predicted under future land use, with increases averaging 15 percent relative to existing land use. The future land use scenarios were simulated under the assumption that the outwash deposit would continue to infiltrate surface runoff from the upper watershed.

The modeling did not find any specific flooding issues for either current or future conditions. However, flooding could occur if the natural function of the outwash deposit was impacted by inhibiting infiltration in the area.

CHAPTER

7 Water Quality Problems

7.1 Analysis of Causes

Analysis of water quality in Inglewood Basin consisted of reviewing previous reports. The last water quality samples in George Davis Creek were collected in the early 1990s by King County. These samples indicated that problem pollutants in the upper basin are nutrients and fecal coliform bacteria, which are pollutants typically associated with livestock. At the time the samples were collected, livestock were prevalent in the upper basin with many landowners operating small hobby farms. In the central basin near the commercial center on 228th Avenue NE, water quality samples contained elevated levels of fecal coliform bacteria, heavy metals, and suspended solids. These are typical pollutants for commercial areas with a broad imperious area and frequent traffic. In the lower basin the main water quality concerns are fecal coliform bacteria and sediment. With less livestock and more housing in the lower basin, the fecal coliform bacteria in this part of the stream could potentially be coming from leaking septic systems; this should be confirmed through testing.

George Davis Creek was listed on the state's 303(d) list of impaired waters because of elevated levels of fecal coliform bacteria. The current status of this creek is uncertain for two reasons. One, no data have been collected in recent years to determine if the pollutants seen in the early 1990s are still problematic in the creek. Two, the state water quality standards have been changed potentially redefining the creek so that it might no longer qualify for the 303(d) list.

Previous state water quality standards categorized water bodies into quality classes of AA, A, B, and C. Each class had a different threshold for each water quality parameters. The new standards classify waters by both the aquatic life that uses them and human recreational uses. The relative significance of each pollutant is listed according to the use that would be affected by that pollutant. Fecal coliform bacteria only have standards set for water bodies that have recreational uses. George Davis Creek is not used for recreation in any fashion and therefore may no longer qualify for impaired status although this determination would need to be made by Ecology.

The Inglewood Basin is a subbasin within the Lake Sammamish watershed. Lake Sammamish provides a wide range of recreational and natural resource opportunities that benefit the more than two million people who inhabit King County and the adjacent counties. The lake is used extensively by boaters, fishermen, water skiers, sail boarders, jet skiers, swimmers, and picnickers. Valuable view properties overlook many parts of the lake. The Shoreline Management Act designates the lake as a resource of statewide significance. The lake provides migratory and rearing habitat for many salmon species as well as being home for many fresh water fish and wildlife. The lake's water quality plays a key role in protecting the lake's recreational uses, its ecological health, and scenic beauty.

In Lake Sammamish, phosphorus is the nutrient that limits phytoplankton (floating algae) growth. If phosphorus is available in excess amounts, it can become a source of pollution and water quality degradation causing the lake water to become green and cloudy and less desirable for public uses and fish and wildlife.

George Davis Creek discharges to Lake Sammamish and is therefore a source of phosphorus to the lake. Mean annual total phosphorus (TP) concentrations of 0.038 mg/l have been reported in the past. This concentration is higher than what is typically seen in Puget lowland streams, which are closer to 0.010 mg/l. No new data are available to determine if the phosphorus loading has changed with increased development.

The movement of sediment is an issue in both the upper and lower areas of the basin. In the upper areas, fine sediment from impervious surfaces has the potential to be carried downstream into the infiltration areas and create clogging in these areas. In the lower areas, slumping occurs along the walls of the canyon downstream of NE 6th Street contributing sediment to the stream that is then washed into the lake during storm events. Large woody debris in the canyon serves to capture a majority of the sediment and maintain the stability of the stream.

7.2 Potential Solutions

Updated water quality sampling would provide information about the current water quality conditions of the stream, and would answer many questions. The knowledge gained by new sampling would include a determination of whether fecal coliform bacteria is still a problem, better estimates for phosphorous loading to Lake Sammamish, and estimates for sediments loads that may be entering both the infiltration areas in the central basin and Lake Sammamish.

The determination of whether or not George Davis Creek should remain on the state’s list of impaired waters needs to be made in consultation with Ecology. If the creek still qualifies for the 303(d) list, then sources of fecal coliform bacteria should be investigated and reduced.

Water quality BMPs as outlined in the 1998 King County Surface Water Design Manual (adopted by the City of Sammamish) provide for both phosphorus and sediment control in new development and for retrofits. This level of control should be sufficient to maintain phosphorus loading at a manageable level for Lake Sammamish as well as to control sediment in the upper basin. It is recommended that the City continue to employ the King County Surface Water Design Manual throughout the basin.

CHAPTER

8 Habitat Degradation

8.1 Analysis of Causes

Aquatic habitat in the Inglewood Basin consists of the wetlands found dispersed throughout the basin and the channel and tributaries of George Davis Creek. There are no endangered or threatened species found within the basin, but preserving these aquatic resources provides multiple benefits to the basin including maintaining hydrologic function and preserving wildlife resources.

The City has adopted King County's Sensitive Area Ordinance (SAO) (2001) on an interim basis for wetlands and streams. The City has made some modifications to buffer widths provided in the SAO for wetlands. Wetlands in the basin are protected under the SAO. Field visits confirm that conditions in the basin's wetlands are generally good. Some concerns have been raised by City staff about dying trees in a large wetland east of 228th Avenue NE and Main Street. An inner ring of trees along the wetland edge has died and it is hypothesized that hydrologic or hydraulic conditions may have changed causing greater inundation in this wetland. A hydrologic study would be needed to the exact cause of this change in wetland size.

The City also follows the SAO (2001) for streams. The City also modified the SAO buffer widths to protect stream corridors. Most of the stream corridors along George Davis Creek are well buffered. Where the creek passes through private property, homeowner activities could potentially impact the creek.

George Davis Creek is reported to have historically supported coho salmon, cutthroat trout, and rainbow trout. The fish barriers at the mouth of the creek, however, now prevent anadromous fish from using this creek.

8.2 Potential Solutions

An investigation of the wetland east of 228th Avenue NE and Main Street would determine if the dead trees around this wetland are a result of hydrologic/hydraulic changes within the wetland. Water quality testing within this palustrine forested wetland would also be prudent to rule out the possibility that pollutants are responsible for the condition of this wetland (i.e., dying trees).

George Davis Creek passes through private property in several areas. Because of this, public education would benefit efforts to preserve the creek's riparian corridor as well as developing a cooperative relationship between the city and the homeowners along the creek.

Daylighting the mouth of the creek would allow fish migration to be reestablished in the lower half mile of the stream where there is perennial flow. The biggest technical difficulty is finding space in between the waterfront homes to create a stream channel. Two viable options are available:

- ***Option 1:*** Purchase a waterfront property along the existing main channel route, remove the building and reconstruct the channel. The gradient in this area is quite steep. Gentle meandering of the channel could be employed to reduce the in-channel gradient. Currently, the channel passes through two waterfront properties (parcel numbers 0777100040 and 0777100045), but only one of them would need to be purchased for channel restoration. The culverts under East Lake Sammamish Parkway and under the homeowner's access road would need to be replaced with fish passable culverts, which would likely require special design.
- ***Option 2:*** Redirect the flow to the north along the unused railroad bed and discharge the creek through an empty parcel. Parcel 3575300002 is south of, and adjacent to, the current overflow discharge location. The lot has no structures and is wooded. The existing railroad bed has room for both the stream and the pedestrian trail that is being planned by King County. Using the railroad bed for the stream channel would also have the benefit of reducing the channel gradient because it provides a somewhat longer route down the slope. As with Option 1, the culverts under both East Lake Sammamish Parkway and the homeowners' access road would need to be replaced with fish passable structures.

After preliminary consideration of these two options, Option 2 has been selected as the preferred option based on technical feasibility, the likelihood of property acquisition, and projected cost.

CHAPTER

9 Basin Plan Recommendations

9.1 Recommended Capital Improvement Projects

Conditions at the Mouth of George Davis Creek

Estimated cost: $1,083,000

Problem: The mouth of George Davis Creek is a barrier to fish as described in Section 5.4.2. In addition, there have been issues at this overflow outfall of deposition of material during large storms that degrade the quality of the beach property.

Solution: Daylight the creek from the east side of East Lake Sammamish Parkway to the mouth (Figure 9-1). Initial field investigations suggest that the creek could be routed to the outlet near the high-flow bypass outfall. This could be accomplished by excavating a channel along side the existing railroad route, which is not currently in use. The creek would be directed north to a currently empty and treed property where it would be discharged to the lake. Sediment traps can be integrated into the channel to reduce the deposition of sediment in the lake.

Benefits: Daylighting the mouth of George Davis Creek would open roughly 2,000 feet of channel to salmon.

9.2 Recommended Programs

9.2.1 Regulatory Programs

Maintain Current Detention Standards

Problem: Upland stormwater management is needed to reduce flooding potential throughout the basin and to limit the flow to the central basin infiltration areas as development in the basin increases.

Solution: Maintain current detention standards for the Inglewood Basin. Currently, the City uses the 1998 King County Surface Water Design Manual in conjunction with the Stormwater Comprehensive Plan as its design standard. This level of stormwater control should be adequate to maintain the hydrologic function in the Inglewood Basin.

Benefits: Controlling flows to infiltration areas will reduce the potential of exceeding infiltration rates and causing flooding. Detention in the Inglewood Basin will help reduce the potential for flooding in other areas of the upland basin as well as maintain the function of the infiltration areas.

Figure 9-1: Fish Passable Open Channel

Encourage Widespread Use of Low Impact Development Techniques

Problem: As development in the Inglewood Basin increases, impervious areas expand and limit infiltration. This basin plan recommends preserving specific infiltration areas in the basin (see Section 9.2.4). However, it is not practical to route the entire basin's runoff to these areas because infiltration rates limit the capacity of these areas.

Solution: In addition to standard detention practices (see program above) encourage and employ on-site infiltration and low impact development techniques wherever feasible. Retrofit existing developments especially those that sit over outwash soils. Low impact development is most effective in areas with well drained soils (see Section 9.2.2).

Benefits: Using on-site infiltration as much as possible will reduce the burden on infiltration resource areas, reduce the detention capacity needed in regional facilities, and reduce the potential for flooding in localized areas.

Maintain Hydraulic Connectivity to Infiltration Areas

Problem: The outwash infiltration area can only serve its beneficial function if water is allowed to reach it. A frequent practice in routing stormwater in urban areas is to put it in pipes, which isolates it from the ground. In the Inglewood Basin, it is desirable to provide as many opportunities for infiltration as possible.

Solution: Use unlined ditches and bioretention swales wherever feasible for stormwater conveyance and unlined detention ponds and infiltration basins for stormwater management in the Inglewood Basin. Route water from the upper portions of the basin to the infiltration areas. Avoid tightlines, which do not provide opportunities for infiltration during routing.

Benefits: Maintaining hydraulic connectivity throughout the basin will maintain the natural hydrologic function of this unique basin by allowing water to pass through the basin's natural outwash areas.

9.2.2 Flood Prevention Measures

Map Infiltration Areas

Problem: Available GIS mapping shows large areas of outwash throughout the central portion of the basin. Not all of these outwash areas are highly infiltrative, however, as is evidenced by large wetlands on the surface over many of these areas. Other factors in the basin soils and geology influence where infiltration is good and where it is difficult. Planning for basinwide drainage requires identifying where infiltration is most feasible.

Solution: Map the infiltration areas throughout the basin based on infiltration rate and capacity.

Benefits: Knowing the locations of the best infiltration areas around the basin will help basinwide planning efforts (see Section 9.2.1).

Identify Potentially Flood Prone Properties

Problem: The potential exists for the infiltration capacity of the outwash areas to be compromised by future development either by clogging of the infiltration area with settleable solids or by exceeding the infiltration rate with increased flow from greater impervious surfaces. If this occurs, water would accumulate on the surface during storms and cause flooding.

Solution: Identify properties near infiltration areas and along upstream corridors that could potentially become flooded if infiltration fails.

Benefits: Knowing in advance what properties are likely to flood if the infiltration capacity of the outwash area is exceeded can provide early warning that stormwater resources in the basin need to be enhanced or repaired.

9.2.3 Stream and Riparian Habitat Improvement and Preservation

Improve Wetland Maps

Problem: The wetland maps currently available for this basin are based upon GIS maps generated by King County and the King County Sensitive Areas Ordinance (see Figure 4-6). When field observations were compared to the GIS information, some inconsistencies were found.

Solution: Field-verify the GIS wetland layer currently available for the Inglewood Basin and update it accordingly.

Benefits: Protecting the basin's natural wetland resources can be done more effectively if the location and extent of these wetlands are accurately mapped.

9.2.4 Critical Areas Conservation

Preserve Infiltration Areas as a Natural Resource

Problem: Natural outwash deposits are currently providing a mitigating effect, protecting George Davis Creek from upland development impacts. The infiltration capacity of this outwash area would be impacted if impervious surfaces are constructed directly over the infiltration areas.

Solution: Designate resource protection areas that protect key infiltration sites that are still undeveloped. Figure 9-2 shows infiltration areas that are suggested for protection.

Benefits: Protecting the infiltration capacity of the outwash in this basin will preserve the natural resource in this basin that maintains moderate flow in the downstream reach of George Davis Creek. This in turn will reduce development impacts on the creek, the risk of erosion in the lower canyon, and sediment deposition in the channel and into Lake Sammamish.

Figure 9-2: Infiltration Preservation Areas

9.2.5 Public Education

Public Outreach and Education Programs

Problem: Several parts of George Davis Creek and its tributaries cross privately owned land. Past experience in the Puget lowlands has shown that property owners, even those with the best intentions, do not always act in the best interest of stream preservation and stream degradation can result from a land owner's actions. This is of particular concern if the resident maintains livestock with access to the creek (see Section 9.2.6)

Solution: Implement a public outreach and education program targeted at those home owners that have aquatic resources on their property. This will allow the City to build relationships with these residents and work in cooperation to improve and maintain riparian corridor conditions. Residents with livestock should be particularly encouraged to participate.

Benefits: Working in cooperation with land owners improves relations between the City and its residents while achieving a positive outcome beneficial to George Davis Creek.

9.2.6 Water Quality Protection Measures

Reduce Phosphorous to Lake Sammamish

Problem: Lake Sammamish is currently receiving an over abundance of phosphorous because of development in its surrounding watershed. Efforts are underway to reduce phosphorous inputs to the lake as much as possible. Because George Davis Creek discharges into Lake Sammamish, all efforts should be made to limit phosphorus in the stream.

Solution: Maintain water quality treatment practices as described in the adopted King County Surface Water Design Manual for developing areas. Phosphorus reduction should be a major focus when designing water quality treatment facilities in this basin.

Benefits: Reducing phosphorus input to Lake Sammamish will help protect recreation and other beneficial uses of the lake.

Remove Solids for Protection of Infiltration Areas

Problem: The capacity of the infiltration area in the Inglewood Basin is highly dependant on the infiltration rate in this area. Fine sediment washing downstream from construction sites, roadways, and other sources could reduce the infiltration rate of the outwash by clogging and thereby reducing the benefit derived from this natural resource.

Solution: Maintain water quality standards for suspended and settleable solids in stormwater runoff in accordance with the adopted King County Surface Water Design Manual. This should apply particularly to construction sites and any areas known to generate large amounts of fine sediment.

Benefits: Reducing the movement of fine sediment in the basin will help to preserve the beneficial function of the outwash infiltration.

Limit Livestock Access to Creeks

Problem: Livestock can do considerable damage to stream banks and affect water quality both by churning up fine sediment and by excreting in the water. George Davis Creek was listed on the State's 303(d) list of impaired waters in the early 1990s because of excessive quantities of fecal coliform bacteria in the water. As growth continues in Inglewood Basin, fewer properties maintain livestock. However, at this time (2004) several places in the upper basin still have farms with livestock.

Solution: Work with landowners to limit livestock access to the upland tributaries and restore stream corridors where possible (see Section 9.2.5).

Benefits: This will help to reduce fecal coliform bacteria in the creek and reduce the transport of fine sediment to the infiltration areas and lower reaches.

9.2.7 Filling Information Gaps

Install Flow Gages in the Upper Basin

Problem: The only flow data currently available for George Davis Creek are from a gage near the mouth. Flow gages have not been installed for tributaries in the upper basin and therefore gage data are unavailable. For this reason, the amount of water currently entering the outwash area cannot be confirmed or monitored.

Solution: Install flow gages on the main tributaries to George Davis Creek. Specifically, gages should be installed where the streams cross 228th Avenue NE south of NE 4th Street and 228th Avenue NE south of Main Street.

Benefits: Recording flows into the outwash area will provide a better understanding of the capacity of this resource as well as provide a means to monitor changes in flow that may result from future development in the upper basin.

Investigate Sources of Fecal Coliform Bacteria

Problem: George Davis Creek was listed on the State's 303(d) list of impaired waters in the early 1990s because of excessive quantities of fecal coliform bacteria in the water. Typical sources of fecal coliform include poorly functioning septic systems, leaking sewer systems, livestock and pet excrement, and ducks and geese in stormwater ponds. The specific sources contributing to high levels of fecal coliforms in George Davis Creek have not been identified. (Note: it is not clear whether George Davis Creek qualifies for the 303(d) list under the new 2004 standards, see Section 7.1.)

Solution: King County monitored water quality in George Davis Creek in the early 1990s. These data should be updated with new water quality testing to determine if the fecal coliform problem persists. If coliform bacteria are still a problem, then the sources contributing bacteria to the creek should be identified and controlled.

Benefits: This will help to reduce fecal coliform bacteria in the creek and also in Lake Sammamish.

CHAPTER

10 References

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Appendix A
HSPF Model Development