

***Edmonds Stream Inventory
and Assessment***

Edmonds, Washington



PENTEC ENVIRONMENTAL

Delivering smarter solutions

Final Report

***Prepared for
City of Edmonds***

***July 29, 2002
Pentec #12130-14***

Edmonds Stream Inventory and Assessment

Edmonds, Washington

Final Report

***Prepared for
City of Edmonds
121 Fifth Avenue N
Edmonds, Washington 98020***

***July 29, 2002
Pentec #12130-14***

***Prepared by
Pentec Environmental***

CONTENTS

Page

INTRODUCTION	1
<i>Purpose</i>	1
<i>Objectives</i>	2
<i>Regulatory Background</i>	2
METHODS	4
<i>Review of Existing Technical Information</i>	5
<i>Stream Survey</i>	5
Reconnaissance	5
Individual Reach Segments	6
<i>Data Analysis and Habitat Assessment</i>	7
STREAM/FISH HABITAT CONDITIONS	9
<i>Perrinville Creek</i>	9
Previous Studies	10
Stream Conditions	10
Water Quality	13
Fish Use and Habitat Assessment	13
Recommendations	15
<i>Fruitdale Creek</i>	16
Previous Studies	17
Stream Conditions	17
Water Quality	18
Fish Use and Habitat Assessment	18
Recommendations	18
<i>Northstream</i>	19
Previous Studies	19
Stream Conditions	19
Water Quality	20
Fish Use and Habitat Assessment	21
Recommendations	21
<i>Shell Creek</i>	22
Previous Studies	22
Stream Conditions	23
Water Quality	25
Fish Use and Habitat Assessment	26
Recommendations	27

CONTENTS (Continued)

Page

<i>Hindley Creek</i>	28
Previous Studies	28
Stream Conditions	29
Water Quality	30
Fish Use and Habitat Assessment	30
Recommendations	31
<i>Shellabarger Creek</i>	32
Previous Studies	32
Stream Conditions	33
Water Quality	34
Fish Use and Habitat Assessment	34
Recommendations	35
<i>Willow Creek</i>	35
Previous Studies	35
Stream Conditions	36
Water Quality	37
Fish Use and Habitat Assessment	37
Recommendations	38
 RECOMMENDATION FOR FUTURE STREAM HABITAT ASSESSMENTS AND HABITAT MONITORING	 39
<i>Streamflow</i>	39
<i>Fish Sampling</i>	39
 REFERENCES	 40

CONTENTS (Continued)

TABLES

- 1 Qualitative Descriptions of Representative Reach Types Found in Edmonds Watersheds
- 2 Stream Channel Data for Representative Reaches

FIGURES

- 1 Watershed Map
- 2 Perrinville Creek
- 3 Fruitdale Creek and Northstream
- 4 Shell and Hindley Creeks
- 5 Shellabarger and Willow Creeks

APPENDIX PHOTOGRAPHS OF STREAMS

EDMONDS STREAM INVENTORY AND ASSESSMENT

INTRODUCTION

On behalf of the City of Edmonds (City), Pentec Environmental (Pentec) conducted an inventory and habitat assessment of the streams within the City's boundaries. The seven streams included within the inventory are those that empty into Puget Sound or the Edmonds Marsh (also known as the Union Oil Marsh): Perrinville Creek, Fruitdale Creek, Northstream, Shell Creek, Hindley Creek, Shellabarger Creek, and Willow Creek (Figure 1). The streams are generally short and relatively steep and are the primary drainage features for surface water, subsurface water, and stormwater for nine of the eighteen watersheds identified within the City (Figure 1). All of these streams contain habitat suitable for resident cutthroat (*Oncorhynchus clarki*) and two of these streams, Willow Creek and Shell Creek, currently support limited numbers of one or more species of anadromous fish, including coho salmon (*O. kisutch*), chum salmon (*O. keta*), and sea-run cutthroat. Other streams may have supported anadromous fish historically (e.g., Perrinville Creek), but no longer do so. Because all of the streams drain (directly or indirectly) into Puget Sound, they could directly affect salmon species listed or proposed for listing under the Endangered Species Act (ESA). This includes the Puget Sound chinook salmon (*O. tshawytscha*) Evolutionary Significant Unit (ESU) and the bull trout (*Salvelinus confluentus*), both of which are listed as threatened, as well as the coho salmon, which is proposed for listing under the ESA. Unlike Pacific salmon, bull trout exhibit a range of life history strategies, from the anadromous form (i.e., saltwater-migrating) to an exclusively stream-resident form. The latter is most often associated with higher-elevation streams and/or headwater streams that are located above impassable fish barriers. However, different forms of the bull trout may co-exist, particularly in larger river systems.

As part of this evaluation, we discuss present and historical fish usage and fish habitat within these seven streams, including potential habitat restoration opportunities.

Purpose

The City of Edmonds needs to establish baseline information on stream conditions in order to support work toward meeting National Pollutant Discharge Elimination System (NPDES) permit and ESA requirements. The City has some information on streams from its previous work on its basin plans, critical areas ordinance, and subsequent individual critical areas studies. However, the City desires to establish a consistent and comprehensive baseline

covering all the appropriate significant streams under the City's jurisdiction. Therefore, the City contracted with Pentec to conduct a review of the relevant technical information, perform a field survey of the streams included in the study, and prepare a technical report that summarizes the results. This report documents the results of those efforts.

Objectives

The City has identified the following objectives for this study:

- Establish baseline conditions and existing status of fish species in study streams.
- Establish baseline conditions and existing status of habitat and stream corridor conditions along study streams.
- Establish baseline conditions and existing status of water quality in study streams.
- Identify potential for fish species or habitat enhancement along study streams.
- Identify recommendations for protection and/or enhancement of fish species, habitat, and water quality. These may include code or regulatory actions, maintenance procedures, and specific engineering or public works projects.

In the following sections we describe our approach to meeting these objectives. As part of this assessment, we address any specific data limitations and identify areas where additional information would allow a more thorough assessment of fish habitat restoration potential.

Regulatory Background

Presently, all activities pertaining to streams and wetlands within the City's jurisdiction are regulated through the Edmonds Community Development Code (ECDC) and Shoreline Master Program (as defined in ECDC 23.10), and are subject to other city, state, and federal laws. Chapter 20.15B ECDC establishes standards and procedures for the protection of critical areas. As defined in ECDC 20.15B.060, critical areas include fish and wildlife conservation areas, frequently flooded areas, geologically hazardous areas, streams, and wetlands (see ECDC 20.15B.020 for specific definitions for each of these areas).

Streams under the City's jurisdiction are further classified into three categories as follows:

Category 1 Streams. Category 1 streams are those streams where the main channel flow is greater than 20 cubic feet per second and the stream meets the criteria for a "shorelines of the state" under the Edmonds Shoreline Master Program.

Category 2 Streams. Category 2 streams are those streams smaller than Category 1 streams and which are perennial; or those that are perennial or ephemeral and are used by salmonids.

Category 3 Streams. Category 3 streams are those streams that are intermittent or ephemeral during years of normal rainfall and are not used by salmonids.

Based on these definitions, all seven streams included in this inventory are classified as Category 2 streams. Although not specifically covered during our field surveys, smaller Category 3 streams may be tributary to some of the larger (Category 2) streams addressed in this study. There are currently no Category 1 streams within the City's jurisdiction.

Pursuant to ECDC 20.15B.120, Category 2 streams with salmonids require a standard 50-foot buffer on each side of the stream, measured from the top of the bank. The standard buffer for those Category 2 streams without salmonids is reduced to 25 feet. Category 3 streams require a 10-foot buffer. As stated under ECDC 20.15B.080, "standard buffers may be increased on a case-by-case basis when [City] planning staff or their representative determines that a larger buffer is necessary to protect the critical area functions and values known to be particularly sensitive to a disturbance." Larger buffers may be required to maintain viable populations of existing species; or if the critical area is used by, or could be potentially used by, species listed or proposed for listing (federal or state) as endangered, threatened, rare, or sensitive. Larger buffers can be required for critical areas located within 25 feet of the toe of slopes greater than 40 percent. Those buffers may also be expanded to include the top of slopes determined to be erosion hazards. In addition, buffers may be increased if the proposed land use "is incompatible with the critical areas in question." Additional standards pertaining to stream crossings, stream relocation, stream channel stabilization, and other development and maintenance activities within the streams or stream buffers are specified in ECDC 20.15B.120.

The City's critical areas ordinance requires a critical areas study be submitted when a development activity is proposed on a site that includes, is adjacent to, or could significantly impact critical areas or their buffers (ECDC 20.15B.140).

Depending on the specific development activity proposed and its likelihood to impact critical areas or their buffers, the City may grant a waiver to the requirement for a more detailed critical areas study. This determination will be based upon a review of the critical areas checklist, a preliminary field investigation, and the review of technical information available to City staff. If potential adverse impacts to critical areas or their buffers are identified, the critical areas ordinance requires mitigation for those impacts. As specified in ECDC 20.15B.150, mitigation includes "avoiding, minimizing, or compensating for adverse impacts to critical areas or their buffers." This is also the priority sequence of mitigation steps (i.e., avoidance then minimization, followed by compensatory mitigation). Compensatory mitigation is required if adverse impacts cannot be avoided altogether or reduced to a level that preserves the function and size of the critical areas. The minimum overall goal of compensatory mitigation is no net loss of the function and size of the critical areas. A set of minimum performance standards for compensatory mitigation, as well as replacement ratios and monitoring, are presented in ECDC 20.15B.150.

METHODS

Baseline fish habitat conditions for the Edmonds streams were established by combining existing information with a new stream habitat survey. The stream habitat characterization generally followed the habitat survey guidelines outlined by the Washington Forest Practices Board's Standard Methodology for Conducting Watershed Analysis, Version 4 (Washington State Department of Natural Resources [WDNR] 1997), although not to the same level of detail. We attempted to walk the entire length of each stream corridor, recording stream habitat conditions and taking photographs to provide a visual record of current habitat conditions. Based on these initial reconnaissance surveys we selected representative stream reaches for more detailed stream habitat analyses, as described in the following sections.

We used the information gathered during these stream surveys, along with existing stream habitat and water quality information, to document the existing fish habitat and characterize it with respect to properly functioning conditions (PFC), as defined by the National Marine Fisheries Service (NMFS). This is described in more detail below.

At the end of this report we suggest additional habitat assessment and monitoring studies that would allow a more in-depth assessment of habitat conditions and fish utilization within the study streams.

Review of Existing Technical Information

We reviewed existing technical reports (obtained from the City and other sources) that documented the conditions within the watershed basins and the seven streams included in this study. The basin studies include:

- Edmonds Drainage Basin Studies: Edmonds Way, Perrinville, and Meadowdale Basins (R.W. Beck 1991);
- Edmonds Drainage Basin Studies – Shellabarger, Five Corners, Northstream, Talbot Park Basins (URS 1989); and
- Shell Creek Basin Study (URS 1987).

We used these earlier studies to supplement the current stream inventory. This also helped us to avoid duplication of effort, particularly where a detailed analysis would not be possible within the available time frame/scope identified for the current survey. However, some of the existing information is more than 10 years old. In general, this was not considered a problem, because the present stream survey (described below) allowed for verification of these stream and fish habitat parameters. Where significant, we have noted the lack of substantive or quantitative data, and/or lapse of time between data collections.

Stream Survey

Pentec staff conducted a field survey to inventory stream corridor and fish habitat conditions for the seven streams included in this study. The stream survey was divided into two principal components: an initial reconnaissance of the seven streams followed by a more detailed survey of selected habitat indicators within representative stream reaches.

Reconnaissance

Pentec staff walked most of the lengths of the seven streams included in the inventory. The intent of the reconnaissance survey was to cover the entire length of each stream (i.e., open channel). However, due to limited access in some locations (e.g., private property or steep terrain), we were unable to survey some stream segments. These stream sections were identified on maps carried by the field crew. In nearly all cases, based on observations from nearby vantage points and from the existing data, the field crew determined these un-walked stream segments were similar in overall characteristics to the accessible reaches either upstream or downstream, or both.

We planned initially to locate stream reaches and reach breaks in the field using Global Positioning System (GPS). It quickly became evident, however, that GPS would not work consistently along stream channels primarily because of steep terrain and dense canopy cover typical within a ravine. Instead, we located stream reaches and habitat features based on direction (i.e., upstream or downstream) and distance from known starting points (e.g., road crossings).

While walking each stream, the survey crew took detailed notes and numerous photos to document existing stream habitat features and conditions. The following data and information were collected:

- Location
- Channel type;
- Flow regime;
- Substrate;
- Gradient;
- Riparian buffer width;
- Riparian vegetation;
- Presence of culverts, waterfalls and other potential fish barriers;
- Culvert diameter/condition;
- Erosion/slope stability problems (general description); and
- Other habitat features (e.g., presence of large woody debris [LWD]).

As part of the reconnaissance survey we delineated reach breaks that define stream reaches (reach types) with similar overall habitat conditions. From these reaches we selected a group of representative stream reaches for collection of more detailed stream channel data.

Individual Reach Segments

Based on data from the stream reconnaissance we identified the following six reach types that were deemed to be representative of most stream corridors within the City of Edmonds:

- Mouth/Lower Reach - Undeveloped
- Mouth/Lower Reach - Developed
- Urban/Residential
- Residential/Ravine
- Park (Maplewood, Yost)
- Park (Southwest County)

Qualitative descriptions of the reach types and the streams to which they apply are presented in Table 1. The Southwest County Park reach type was designated because of the unique characteristics of the Perrinville Creek stream corridor within the Southwest County Park, which differs substantially from conditions within Maplewood and Yost parks (Northstream and Shell Creek, respectively).

Applying these reach types to the entire study area necessitated generalizations regarding a range of habitat features and conditions. Nonetheless, this level of generalization was necessary to reduce the total number of representative reach types to a manageable number. We surveyed each reach type, collecting stream channel and fish habitat data from a representative sampling of the different streams. This seemed to be a reasonable compromise that helped to reduce costs (versus additional field effort) while still providing a useful descriptive data set to help meet the objectives of this study. The stream channel and habitat parameters collected during each survey included:

- Reach type;
- Flow regime;
- Substrate (including embeddedness);
- Channel characteristics (width, depth, gradient, and confinement);
- Pool characteristics (percent and size);
- Percent disturbance (channel/bank hardening by length);
- Riparian vegetation; and
- LWD.

Data Analysis and Habitat Assessment

Information from the basin reports, critical areas studies, and other existing sources, and data collected in the stream reconnaissance and reach surveys were used to establish current or baseline stream habitat conditions within the study area. From this information we attempt to characterize stream habitats with respect to PFC. NMFS uses the concept of PFC in evaluating the freshwater environment as it relates to the biological requirements of salmon and steelhead. The term is defined by NMFS as "the sustained presence of natural habitat-forming processes in a watershed (e.g., riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of threatened salmon and steelhead through the full range of environmental variation" (NMFS 1999).

Within this PFC framework, baseline environmental conditions ("condition indicators") are described as properly functioning, at risk, or not properly

functioning. For example, the formation of pools in a stream is an important process that contributes to in-channel complexity, an important fish habitat element. The pools provide refuge for salmonids. The pool size (area and depth) and pool ratio (pool habitat per length of channel), among other measurable attributes, are indicators of pool quality, and hence are indices of fish habitat quality. Values for various pool quality indicators are compared with the values in the literature (presenting optimum conditions) and ranked in terms of habitat quality. Although there are no minimum standards, a stream with moderate to high values for pool quality (based on multiple indicators) would be considered properly functioning for this condition indicator. Conversely, low values for those same condition indicators would signal the stream is not properly functioning with respect to pool formation/channel complexity. The latter can be a result of lack of LWD, steep gradient, frequent high flows, and channel/bank instability as well as channel/bank hardening (or a combination there of).

The term "at risk" is generally applied to habitat indicators that are properly functioning at present, but likely to become impaired in the future should present conditions within the drainage basin change (i.e., become degraded). Using the previous example regarding pool habitat quality, the clearing of vegetation within the riparian zone, including the removal of larger trees, cuts off the supply of new LWD from the cleared area. If this area represents a significant source of LWD to the stream, the stream can be considered at risk from the loss of LWD recruitment. For most streams, without new inputs of LWD, the number and size of pools formed within the channel eventually decrease, reducing channel complexity. Additional adverse impacts to fish habitat will result from the loss of pools, which among other functions, help to reduce stream velocities and remove suspended sediments, which can degrade spawning and rearing habitat.

Extensive development within the Edmonds stream corridors including (but not limited to) clearing and grading, construction of roads and other impervious surfaces, as well as stream channel modifications (e.g., bank hardening, culverts, etc.) has previously degraded much of the habitat value of these streams as compared with predevelopment conditions. Such development is typical within a mostly urban environment. As described in the following individual stream habitat descriptions, with few exceptions (e.g., park reaches), most of these baseline habitat indicators are presently not properly functioning or are at risk. In addition to documenting these problems, this baseline stream assessment can be used to help identify those areas with restoration potential.

STREAM/FISH HABITAT CONDITIONS

After a brief description of each stream, we present the results of the survey as follows:

- Previous Studies;
- Stream Conditions;
- Water Quality;
- Fish Use and Habitat Assessment; and
- Recommendations (Fish Habitat and Fish Passage).

The attached appendix provides photos taken during the surveys. Under "Recommendations" we identify improvements to fish habitat and fish passage within the stream. We focus our attention on those specific locations (e.g., culverts and reaches) that we believe would have the most significant or direct impact on the stream's ability to support anadromous and resident fish populations. Some projects would obviously entail significant engineering and construction costs, whereas other projects could be done at much lower cost. No detailed cost analyses are provided for these improvement projects, however. Where appropriate (e.g., stream clean-up and riparian replanting projects), community (i.e., volunteer) participation and outside funding sources would significantly reduce costs to the City. Such community projects have already been conducted. Outside funding sources that could allow at least partial funding of these projects would include state grant programs for salmon enhancement (e.g., Salmon Recovery Funding Board) and private grants through not-for-profit foundations. In addition, some projects could be accomplished as mitigation for development or construction projects (e.g., shoreline development).

Perrinville Creek

Perrinville Creek is a Category 2 stream that drains the 920-acre Perrinville Basin in northern Edmonds and western Lynnwood. The main channel begins at the intersection of Olympic View Drive and 76th Avenue W, where it emerges from a culvert at the corner of the Post Office property. The creek flows to the north and northwest through a steep ravine in the Southwest County Park, exits the northern boundary of the park, and continues in a northwesterly direction crossing Talbot Road and the Burlington Northern Railroad (BNRR) tracks, where it enters Puget Sound. The main creek channel is approximately 1 mile in length and drops about 400 feet in elevation (Figure 2).

Previous Studies

A relatively large amount of information concerning Perrinville Creek has been collected and presented in two main studies. The Edmonds Drainage Basin Studies: Edmonds Way, Perrinville, and Meadowdale Basins (R.W. Beck 1991) addressed surface water management and primarily focused on water quantity and quality control as well as enhancement of wetlands, riparian corridors, and fisheries. Among the stated long-term goals was enhancement of "the fisheries resource by improving habitat and removing obstructions in stream systems capable of supporting fish habitat." The basin study included a fish habitat survey of Perrinville Creek and documented 11 problems related to water quantity and quality, streambank and channel erosion, sedimentation, and fish passage. Most of these problems occur from Talbot Road upstream to the headwaters and many of these problems were evident in the current stream survey, as discussed in more detail below. In addition to identifying the major problems affecting Perrinville Creek, the 1991 basin report provided alternative solutions and recommendations, including estimated costs.

Based in part on the findings of the 1991 basin report, the City contracted with Pentec and Shannon & Wilson, Inc., to develop a stream restoration plan that focused on stabilizing the eroding streambanks from the Talbot Road crossing to the northern boundary of Southwest County Park. The Perrinville Creek Streambank Stabilization report (Pentec and Shannon & Wilson 1998) evaluated hydrology (streamflow estimates) and stream channel attributes within the study area, which included approximately 1,400 feet of the stream channel. A detailed stream map, including cross sections, was prepared by Reid Middleton in 1997 and served as the base map for the 1998 study. The stabilization report presented data on condition, streambank stability, streambank/streambed geology, LWD, fish habitat, and pebble counts. This study provides the bulk of the current information concerning fish habitat in Perrinville Creek. We summarize the findings along with our fish habitat assessment below.

Stream Conditions

Stream Mouth to Talbot Road

The survey of Perrinville Creek began from the outlet on the downstream side of the 30-inch culvert beneath the BNR tracks (Appendix; Photo P-1). Upstream of the railroad tracks, the creek flows for approximately 500 feet through residential properties west of Talbot Road (Figure 2). The channel substrate in this reach is mostly gravel and sand, with some larger material. The channel gradient approximately midway between the mouth and Talbot Road is 4 percent. Streamside vegetation varies between the landscaped (typically

in this reach, with gravel as a lesser component. The slope failures do result in abundant LWD inputs to the stream channel, a process that normally helps create more pools and increases channel complexity. However, in the more confined areas the high stormwater volumes undermine the process, resulting in channel instability. The channel instability and slope failure problems that affect this area have been well documented. Our survey verified the continuation of these problems.

The channel gradient through the lower portion of the ravine is steeper than it is between the mouth and Talbot Road. Stream channel gradients in the ravine above Talbot Road vary widely but generally range between 4 and 8 percent, with vertical drops in some locations that form small (3- to 5-foot-high) waterfalls. The pool ratio (pool length/channel length), as determined within a representative segment, is about 7 percent (Table 2). However, these pools are relatively shallow (less than 3 feet) as a result of sediment accumulation. Relatively few pools (approximately 50 percent) have been formed by LWD.

Farther upstream within the Southwest County Park reach the gradient is generally lower (2 to 5 percent) and the channel migration zone is often wider compared with the lower ravine. Where the floodplain is widest the channel is occasionally braided. Progressing upstream the ravine slopes become less steep and there is less evidence of toe-slope erosion and channel scour. As a result, gravels are generally more abundant than sand. Woody debris is typically embedded and does not migrate to the extent that it does in the lower reach. The pool ratio is about 21 percent, and most of these pools have been formed by LWD (Table 2). The pools in this reach are also generally larger (in area) than pools in the lower ravine, but still relatively shallow (less than 3 feet). Two small tributaries enter the main channel near the upper end of the reach.

Above the ravine the stream passes through a residential area with some homes within 30 feet of the streambanks. The trees along this segment of the creek are smaller and younger (typically alders) in comparison to the mature evergreens that are found within the park (Photo P-11). Himalayan blackberry is prevalent in this area. Toward the upper end, the creek passes through a 48-inch culvert below the Perrinville Post Office. Upstream, the riparian buffer alongside the Post Office has been replanted with native vegetation and maintained on a yearly basis by students from Seaview Elementary (Shepard, B., personal communication, May 14, 2002). What were formerly patches of Scots broom and Himalayan blackberry are now more diverse patches of willow, alder, black cottonwood, bull rush, salmonberry, huckleberry and native roses. The survey ended at the 76th Avenue W culvert.

Water Quality

No water quality sampling was conducted as part of this inventory and there is very little existing quantitative data available. In general, water quality in Perrinville Creek is primarily affected by frequent inputs of sediments (sand and fines) that erode along the steep slopes and channel walls, particularly in the lower portions of the ravine. Although most pronounced in the lower reaches, turbid water is also observed at the upstream end of the main channel as a result of surface runoff from the surrounding, largely urbanized plateau that forms the headwaters. High levels of suspended sediments can harm fish both by smothering and suffocating incubating eggs that have been deposited in the spawning gravels and by clogging the gill filaments of juvenile and adult fish. As evidenced during the current survey, high levels of turbidity are common in Perrinville Creek during and following storm events.

Perrinville Creek may also receive inputs of chemical contaminants; primarily oil and grease from road surfaces, and fertilizers/pesticides from adjacent residential properties. Chemical contaminants may also enter the stream through illegal dumping. However, we have no data to gauge the impacts, if any, of these contaminants on fish and other aquatic life in Perrinville Creek. Because of existing laws and regulations concerning stormwater and municipal wastewater collection and treatment, current levels of most surface-borne contaminants would not be expected to have significant long-term impacts to aquatic life in Perrinville Creek. While the possibility of accidental spills exists, any impacts associated with such spills, while potentially severe, usually are localized and temporary.

Public awareness programs have generally helped to reduce the overuse of fertilizers and pesticides, although this likely continues to occur. A more concentrated public awareness campaign that focuses on adjacent property owners may be helpful in reducing potential adverse impacts from nutrient loading (from fertilizers) and pesticide poisoning.

Water temperatures are not likely to be limiting during most of the year. However, along the developed sections of the stream, riparian canopy coverage is sparse and may contribute to elevated water temperatures during summer months. No temperature data exist to confirm this.

Fish Use and Habitat Assessment

The present survey assessed fish habitat conditions within Perrinville Creek; however, no fish sampling was conducted and no other signs of spawning activity were observed (e.g., spawning adults or carcasses). Other studies have

provided information on habitat conditions but information concerning fish usage in Perrinville Creek is scarce. In 1990, the Washington Department of Fish and Wildlife (WDFW) sampled (electroshocked) a section of Perrinville Creek downstream of the intersection between Olympic View Drive and 76th Avenue W (Figure 2). WDFW reported the presence of resident cutthroat trout as long as 9 inches just below the intersection (Schneider, P., Washington Department of Wildlife [WDW], personal communication, December 3, 1990). In addition, WDFW observed some excellent spawning habitat between 76th Avenue W and Talbot Road, but noted the sedimentation problem caused by severe erosion in the park (Schneider, P., WDW, personal communication, January 10, 1991). The 1991 basin report noted that a homeowner near the mouth of Perrinville Creek had observed fish ascending a 100-foot-long fish ladder that had been constructed just upstream from the railroad tracks (R.W. Beck 1991). However, no additional information regarding species was provided. WDFW has not conducted any recent fish surveys in this stream (Pentico, E., WDFW, personal communication, January 22, 2002).

Since 1994, students from Seaview Elementary have released approximately 300 juvenile chum salmon into Perrinville Creek each year as part of a class science project (Shepard, B., personal communication, May 14, 2002). The salmon fry are first reared in the classroom and then released into the pool below Talbot Road. However, to date, no adult returns have been reported. In addition to these annual releases by Seaview Elementary, it was reported that as many as 3,000 juvenile chum salmon were released into Perrinville Creek in 2001 by students from a private school (Shepard, B., personal communication, May 14, 2002).

Other than resident cutthroat trout and the chum salmon fry released by school students, we found no other specific accounts of salmonid usage in Perrinville Creek. We found no evidence to suggest any present or historic use of Perrinville Creek by chinook salmon or bull trout. Chinook salmon generally spawn in larger rivers and therefore are unlikely to have ever been found in this stream.

Although only the lower reach of Perrinville Creek is accessible to anadromous fish, the habitat survey conducted in 1990 determined that Perrinville Creek contains "a significant amount of fair to good spawning and rearing habitat potential from its mouth through the [park] up to the culvert at 76th Avenue West" (R.W. Beck 1991). The study concluded, however, that the existing quality of this reach as spawning habitat was "markedly reduced" by the high sediment loads. In terms of accessibility, the culvert at Talbot Road was identified as a major obstacle to restoring anadromous fish runs in Perrinville Creek. The study emphasized that without control of sediment inputs,

replacement of this culvert and other fisheries enhancement efforts would be ineffective.

Our reconnaissance of Perrinville Creek indicates generally good spawning habitat currently exists in the stream's lower reach up to Talbot Road. As indicated in the previous studies, the existing culvert at Talbot Road is a complete barrier to upstream fish passage. Above Talbot Road and extending upstream into the park there are areas containing spawning gravels, although, as described in the previous studies, and verified during the current stream survey, the high sediment loads and channel scour in the lower reach areas severely degrade spawning habitat quality.

Bull trout are particularly sensitive to the effects of sedimentation. In addition, bull trout prefer cool, well-oxygenated water. Thus, it is unlikely that spawning bull trout populations would be found in any of the study-area streams. However, bull trout originating from other river systems (e.g., the Snohomish River) may feed around the mouths of the larger streams during the juvenile salmon outmigration.

Even if the Talbot Road culvert were replaced to allow adult fish to pass, other impassible barriers exist beginning approximately 600 feet upstream that would prevent the fish from reaching areas farther upstream where additional spawning and rearing habitat exists. As indicated in the 1998 study, substantial reengineering of the existing channel would be required to remove fish passage barriers that currently exist in the lower ravine.

Recommendations

Fish Habitat Improvements

The Streambank Stabilization report (Pentec and Shannon & Wilson 1998) identified a number of measures to improve channel and slope stability and help improve fish habitat quality in Perrinville Creek. While acknowledging the overall challenges associated with controlling excessive flows, the study focused on bioengineering solutions within the reach between Talbot Road and the northern boundary of Southwest County Park. Please refer to this report for specific recommendations.

In addition to stabilizing the stream channel, the goal of any channel restoration project in this stream should be to increase both the quantity and quality of pool habitat, and provide more instream cover, which is one of the main limiting factors for juvenile fish. Note however, that underlying stormwater/peak-flow problems need to be addressed for long-term improvement in Perrinville Creek.

Previously recommended improvements include storage retention/detention facilities (refer to 1991 basin study). Due to the geology, the lower ravine will always be a dynamic area and any spawning habitat improvements here are likely to be limited.

In addition to these stream channel improvements, the riparian buffer, particularly along the disturbed areas, could be improved through removal of invasive plants and replanting with native species, similar to the on-going efforts by Seaview Elementary students at the Post Office site. Like the Post Office site, riparian restoration could be accomplished through volunteer efforts (e.g., as an Earth Day project for a school group) or through a nonprofit community environmental organization (e.g., Adopt-A-Stream). Grants may be available to help purchase plants and other restoration materials. Due to the limited public access to the stream, a public education/awareness effort focusing on local residents, particularly the adjacent property owners (e.g., via door-to-door campaign and/or targeted mailings), may be an effective method of gathering/organizing community support. Additional information and guidance on such community efforts may be available through Snohomish County (e.g., the Watershed Stewardship Program and the Native Plant Program) and from nonprofit environmental organizations such as Adopt-A-Stream.

Fish Passage Improvements

A number of fish passage barriers have been identified on Perrinville Creek, the most prominent being the culvert beneath Talbot Road. As previously suggested, removal of this culvert would allow adult fish access to at least 600 additional feet of Perrinville Creek above Talbot Road.

It is assumed the City monitors culverts and performs maintenance as necessary to clear debris that has caused blockages. However, as evidenced by the present stream reconnaissance (e.g., Talbot Road), the speed at which blockages can develop at some locations during/following storm events suggests more frequent inspections are warranted during the fall/winter. The City is aware of the regular "trouble spots" and has already made improvements, or has plans to make improvements, such as replacement of existing pipe culverts with larger open-channel (box or arch-type) culverts. As described above (i.e., Talbot Road), the City is sometimes limited in its ability to make permanent fixes.

Fruitdale Creek

Fruitdale Creek is a Category 2 stream and is the major drainage feature of the Talbot Park basin. The creek drains approximately 143 acres (URS 1989). The main channel begins near 194th Street SW. The creek flows west and northwest

crossing Olympic View Drive, Cherry Street, Sound View Place, and the BNRR tracks, where it enters Puget Sound (Figure 3). The main creek channel is approximately 0.75 mile in length and drops about 400 feet in elevation.

Previous Studies

The only source of background information on Fruitdale Creek available is the Edmonds Drainage Basin Studies – Shellabarger, Five Corners, Northstream, Talbot Park Basins (URS 1989). Similar to the City's other drainage basin studies, the purpose of the 1989 study was to provide a comprehensive review and analysis of surface and stormwater management within the specified basins. The report identified existing and potential erosion and channel capacity problems affecting Fruitdale Creek and other areas within the Talbot Park basin. In response, the City in 1994 installed a stormwater bypass near Cherry Street.

Although the basin studies did not specifically identify fish habitat as an objective, reference is made to "the concern for the fisheries resource in the stream systems." Appendix E of the report summarizes the effects of urbanization on streams and wetlands and provides stream corridor protection and restoration measures. Very little site-specific information for Fruitdale Creek is provided, however.

Stream Conditions

The survey of Fruitdale Creek began from the outlet on the downstream side of the concrete culvert beneath the BNRR tracks (Photo F-1). At the time of the survey the culvert was approximately 40 percent clogged with gravel. Just a short distance upstream of the first culvert the creek flows through a second culvert for approximately 30 feet (Photo F-2). Upstream of the second culvert the creek passes houses constructed close to the channel on both banks. The channel gradient here is about 6 percent and the substrate is predominantly sand and gravel. Several old discarded tires were observed embedded in the channel (Photo F-3). Vegetation in the lower reach consists primarily of non-native species (e.g., morning glory, ivy, grasses).

Farther inland the stream passes through another culvert beneath Sound View Drive. At the time of the survey, this culvert appeared to be about 50 percent blocked with sediments and other debris. A flood control structure consisting of a concrete wall with a 12-inch metal pipe was constructed across the creek approximately 100 feet upstream of Sound View Place (Photo F-4). A short distance above the control structure the creek passes through heavily landscaped and terraced back yards where a series of manmade pools have been created (Photo F-5). This is the common theme for most of the channel's

length upstream to Olympic View Drive (Photo F-6). Above Forest Dell Drive, Fruitdale Creek flows through a less developed residential ravine containing some LWD and a riparian buffer (Photos F-7 and F-8).

Water Quality

No water quality sampling was conducted as part of this inventory and no other sources of existing quantitative water quality data were identified. Because of surrounding upland development, water quality in Fruitdale Creek is potentially affected by inputs of sediments (sand and fines) that erode along the streambanks, and inputs of chemical contaminants, primarily petroleum products, fertilizers, and pesticides. Riparian canopy coverage is sparse and may contribute to elevated water temperatures during summer months. No temperature data exist to confirm this. We have no reason to suspect that chemical contaminants have had significant long-term impacts to aquatic life in Fruitdale Creek. Although the possibility of accidental spills exists, impacts associated with such spills, while potentially severe, are usually localized and temporary.

Fish Use and Habitat Assessment

Our survey assessed habitat conditions within Fruitdale Creek; however, no fish sampling was conducted and no signs of spawning activity were observed. In addition, WDFW has not conducted any recent fish surveys in Fruitdale Creek (Pentico, E., WDFW, personal communication, January 22, 2002). As reported in the 1989 basin study, a fish habitat survey conducted in 1985 (no reference identified) found no fish (although the survey timing and methods were not discussed) and concluded that little instream habitat exists. The present stream reconnaissance verified the relative lack of spawning and instream habitat. Thus, there is no evidence to suggest present or historic use of Fruitdale Creek by chinook salmon or bull trout.

Recommendations

Fish Habitat Improvements

Habitat restoration efforts on Fruitdale Creek should be focused on improving instream habitat, where possible. Since most of the channel runs through residential properties, the active involvement of adjacent property owners is required. Those property owners need to be willing to remove riprap and other channel structures that affect flow characteristics and limit pool formation. Additionally, property owners could improve riparian conditions by removing invasive species where present, and planting native shrubs and trees to increase

streamside shading. Except for road crossings and utility corridors, the City has few options for direct habitat improvements.

Because of the comparatively small size of Fruitdale Creek, and the limited ability of the stream to support fish, it is suggested that habitat restoration and enhancement efforts first be undertaken on the streams that are known to currently support anadromous salmonids (i.e., Shell and Willow creeks) or at least have a greater potential for supporting anadromous fish (Perrinville Creek).

Fish Passage Improvements

Considering the relatively limited potential for restoring anadromous fish runs to Fruitdale Creek, no major fish passage improvements are recommended at this time. However, as previously suggested (assuming it is not currently performed on a frequent basis), regular inspection of culverts and removal of accumulated debris is recommended during the fall and winter seasons.

Northstream

Northstream is a Category 2 stream that drains the 248-acre Northstream Basin (URS 1989). The open channel begins near Maplewood Park and the creek flows west and northwest crossing 196th Street, Olympic View Drive, 9th Avenue N, and the BNRR tracks before entering Puget Sound (Figure 3). The main creek channel is approximately 0.75 mile in length and drops about 400 feet in elevation.

Previous Studies

Information on Northstream was presented in the City of Edmonds Drainage Basin Studies – Shellabarger, Five Corners, North Stream, Talbot Park Basins (URS 1989). The 1989 basin study identified existing and potential erosion and capacity problems affecting the Northstream channel and other areas within the basin. Stormwater retention/detention was identified as the primary need in the basin. The study suggested that after flows are brought under control, a stream channel and habitat restoration program should be undertaken.

Stream Conditions

Our survey of Northstream began from the outlet of the 36-inch concrete culvert beneath the BNRR tracks (Photo N-1). Immediately upstream of the railroad, Northstream passes through a residential area. The channel walls here are lined with concrete and riprap, and the creek bed is composed of embedded gravels and sand, with some cobbles (Photos N-2 and N-3). There is little vegetation.

Upstream of the concrete channel, the creek winds approximately 500 feet through a floodplain covered with grass, clover, and English ivy (Gates property at 750 Northstream Lane; Photo N-4). The stream contains a series of short steps and shallow pools (Photo N-5). The substrate here is mainly composed of sand and embedded gravels. The slopes throughout the lower reach are gradual, 3 to 4 percent (Table 2). Residents reported that great blue heron regularly fish along the stream, and indicated that a river otter lives in the area and is occasionally seen along the lower reach.

Progressing upstream, Northstream flows past the former site of a 1920s-era shingle mill (Daniels property). An 8-foot waterfall forms an impassable fish barrier (Photo N-6). Above the old mill site, the stream flows through a residential reach that in some locations contains native vegetation interspersed with ornamentals (Photo N-7).

Farther up the hillside, after passing through more residential properties above 9th Avenue S, Northstream is culverted beneath 196th Street for several hundred feet. Photo N-8 shows the upstream entrance to the 24-inch-diameter culvert, equipped with a debris catch, on the east side of 12th Avenue N. Immediately upstream of the culvert entrance in the channel is an old concrete structure, likely an overflow (Photo N-9). Two of the three openings (near the bottom) were plugged with debris and sediments. The residential reach immediately above 12th Avenue N includes sections with dense streamside vegetation (Photo N-10) and moderate amounts of wood in the stream channel. Farther upstream, within Maplewood Park, at the time of the reconnaissance survey (late November) the stream went subterranean in one channel section near the main park trail before reappearing upstream.

Water Quality

No water quality sampling of Northstream was conducted as part of this inventory and no other sources of existing quantitative data were identified. Because of surrounding upland development, water quality in Northstream is potentially affected by inputs of sediments (sand and fines) that erode along the streambanks, and inputs of chemical contaminants, primarily petroleum products, fertilizers, and pesticides. We have no reason to suspect that chemical contaminants have had significant long-term impacts to aquatic life in Northstream. Although the possibility of accidental spills exists, impacts associated with such spills, while potentially severe, are usually localized and temporary. Riparian canopy coverage is sparse and may contribute to elevated water temperatures during summer months. No temperature data exist to confirm this.

Fish Use and Habitat Assessment

No fish sampling was conducted in Northstream as part of the current inventory. When contacted for information regarding fish usage, WDFW indicated it has not conducted any recent fish surveys in this stream (Pentico, E., WDFW, personal communication, January 22, 2002). There is no evidence to suggest any present or historic use of Northstream by chinook salmon or bull trout.

Our surveyors did observe fish (assumed to be cutthroat) in the reach below the impassable waterfall at the former mill site. No signs of spawning activity were observed. As reported in the 1989 basin study, a 1985 fish habitat survey concluded that lower Northstream has "a high potential for fish use, but that a number of channel restoration and protection features are necessary to realize this potential" (URS 1989). These habitat improvements are addressed below.

Recommendations

Fish Habitat Improvements

The recommended fish habitat improvements outlined in the basin study included gravel cleaning or replacement, and channel, bank, and riparian zone rehabilitation projects (URS 1989). Based on the current conditions in Northstream, we generally concur with this assessment. Similar to the other streams within the study area, the lack of adequate instream habitat is a major limiting factor in the stream's ability to support fish. Recommended improvements require the direct (and ongoing) involvement of adjacent property owners and their willingness to make the types of channel and riparian buffer improvements (previously described) that benefit fish.

As previously suggested, given the reality of limited funding resources, habitat restoration and enhancement efforts should first be focused on those streams that have the greatest potential for restoring anadromous fish runs.

Fish Passage Improvements

Fish access is restricted to the lower reach below the 8-foot drop at the site of the former shingle mill. Allowing fish access above the barrier would require a ladder or other channel bypass of some type. Engineering and construction costs for such a bypass would likely be substantial. Fish passage improvements in the larger streams should be prioritized above this potential improvement.

Shell Creek

Shell Creek is a Category 2 stream that receives urban runoff from the 806-acre Shell Creek Basin (URS 1987). The Shell Creek Basin includes both the Shell Creek (628 acres) and Hindley Creek (178 acres) drainage basins. In addition, Shell Creek receives overflow—primarily during the winter months—from Good Hope Pond and Westgate Pond. Beginning east of Yost Park, Shell Creek flows to the northwest through the park and the downtown area, then crosses 7th Avenue and turns toward the north toward the Strickland property (adjacent to the Puget Sound shoreline), where it crosses the BNRR tracks before entering Puget Sound (Figure 4). Hindley Creek, a tributary, enters Shell Creek west of Brookmere Drive, approximately 1,100 feet upstream from the mouth. One of the significant features of Shell Creek is the relatively undeveloped mouth and lower reach segment, which is associated with a Category 2 wetland.

Previous Studies

Information on Shell Creek was presented in the Shell Creek Basin Study (URS 1987). The basin study addressed surface and stormwater management issues within the Shell Creek Basin and provided recommendations for improvements to the existing storm drainage facilities. Specific problems identified for Shell Creek included severe erosion in the reach between 7th Avenue N and 8th Avenue N, and flooding during storm events between the Hindley Creek confluence and 7th Avenue N. The latter was attributed to decreased channel depth resulting from severe sedimentation. In addition, flooding was reported upstream of culverts at 7th Avenue N and Daley Street (URS 1987). As a result of the basin study, in 1990 the City installed a stormwater bypass (pipeline) including a diversion structure at Daley Street designed to divert peak flows from the stream channel. Also that year the City installed log bank-stabilization structures and check dams between Sprague Street and Main Street.

The 1987 basin study provided very little information on fish habitat and fish usage in Shell Creek. However, the study noted that it might be feasible to restore fish runs on Shell Creek through removal of obstructions, realignment of culverts, and enhancement of streambeds and habitat. The report recommended changes to ECDC to strengthen stream preservation and protection by requiring stream restoration measures when rechanneling is needed.

The second document reviewed for this current inventory was the Strickland Critical Areas Study (Pentec 2000). This study described a segment of Shell Creek and an associated Category 2 wetland located within a 7.5-acre privately owned parcel near the mouth as part of a proposed variance to the existing

ECDC wetland buffer. The study concluded that the proposed buffer reduction was justified due to the net gains in functional value for a new, restored wetland buffer at the site.

Stream Conditions

The lower portion of Shell Creek flows through the largely undeveloped Strickland property, which includes the land on the east side of the BNRR tracks as well as portions of the tideflats to the west (Figure 4). Shell Creek discharges to Puget Sound through a 36-inch concrete culvert beneath the BNRR right-of-way (Photo S-1). Beginning a short distance upstream from the culvert the creek splits into two channels (east and west channels) for a distance of approximately 500 feet. Both channels are generally unconfined and flat (1.5 percent gradient) and contain very little pool habitat (Table 2). The east channel is slightly larger (channel width) than the west channel, has more meanders, and is also slightly longer than the west channel. Spawning gravels are plentiful in both channels and each possesses a well-established riparian buffer (Photo S-2). At the time of our initial survey (late November), six salmon carcasses were observed (Photo S-3). These appeared to be chum salmon (*O. keta*), although some of the fish were too decomposed to be identified with confidence.

A small (<0.25 acre) man-made pond has been constructed between the channels. The pond is fed by a ditch that splits off from the west channel. A gate in the ditch controls the inflow, which first enters a small pool. At the opposite end of the pool, a 6-inch culvert leads into the main pond (Photo S-4). Water in the larger pond drains from the opposite (i.e., downstream) end through a corrugated pipe to the east channel. The amount of inflow is controlled at the gate and is dependent on stream flows. Water was observed flowing into the small pool and pond in late November 2001. However, during a survey of the site conducted in March 2000, no flow was observed entering the pool/pond (Pentec 2000). Although no fish were observed during our current survey, it would appear that smaller fish could enter the small pool and potentially become trapped. A screen between the small pool and the larger pond likely prevents fish from entering the pond.

At the upper end of the property, approximately 30 feet above the east-west channel split, a fence was constructed across the creek channel along the property boundary. At the time of our survey, leaves and other debris had partially clogged the chain-link fence, resulting in flow restriction and some backup on the upstream side (Photo S-5). The fence does not extend to the bottom of the channel however, and therefore would not appear to prevent fish passage from one side to the other.

Upstream (south) of the Strickland property the creek takes on an urban/residential characteristic as it flows past (primarily) single-family residences (Figure 4). In general, the riparian buffer throughout this reach (i.e., to upstream past Daley Street) is much reduced or nonexistent, depending on individual building setbacks and landscaping features. However, some properties have retained a functional buffer, as described below.

Hindley Creek, which is addressed in the following section, enters Shell Creek at approximately 1,100 feet upstream from the mouth. The 1991 Snohomish County Critical Areas inventory indicates a wetland is associated with this reach segment (Figure 4). While we did not survey the extent of the wetland boundary, there appeared to be a wider riparian buffer here.

A few hundred feet to the south, Shell Creek flows beneath Caspers Street (State Route [SR] 524) through a 4-by-8-foot box culvert. The Shell Creek Basin report noted the opening of the culvert has been reduced substantially (to 2 by 8 feet) as a result of severe sedimentation from channel erosion upstream. The report also indicated that because of the shallow channel, flooding along this stream reach was common during storm events. We have no long-term flow data or stream gauge data available, or other documentation to verify the extent of this problem. The stormwater bypass installed in 1990 has likely reduced both the peak-flow volumes and frequency of floods, however. There was some debris in the channel near the entrance to the culvert at the time of our survey, but the culvert appeared to be in good condition and no flooding was observed. In any event, it is known that frequent flooding and severe sedimentation occur in other streams/reaches covered in this inventory (e.g., Perrinville Creek) and this greatly affects the quality of salmonid spawning and rearing habitat in those streams.

Upstream of Caspers Street, the channel continues southward (parallels 7th Avenue) through a residential area, including single-family homes and a condominium complex (Creskide Condominiums) before turning southeast beneath 7th Avenue (via a 24-inch by 75-foot culvert). Upstream of 7th Avenue, Shell Creek flows past the Holy Rosary Church Rectory (southwest corner of complex) and additional residences along Daley Street. This section of the reach, with a 3 percent gradient and gravel/sand substrate, contains suitable spawning and rearing habitat. The riparian buffer generally includes some native vegetation (again depending on adjacent landscaping) and larger trees that provide shade and nutrient inputs (Photo S-6). Immediately upstream, the City in 1990 installed a new fish ladder and diversion structure at Daley Street (Photo S-7).

Along the channel upstream of Daley Street there is a dense understory dominated by Himalayan blackberry (Photo S-8). Here, the channel characteristics generally change from those of an urban/residential channel (i.e., decreased buffer width, less vegetation, and more riprap) to a residential ravine (i.e., generally a thick understory, with steep banks and homes that are usually set back from the top of the ravine). These general channel characteristics continue for most of the distance upstream to Main Street. A number of log check dams and bank-stabilization structures were installed along this section of the creek (e.g., Sprague Street to Main Street) in 1990 as part of the stream restoration efforts.

Although primarily open channel in this section, Shell Creek is culverted for 160 feet beneath 9th Avenue (48-inch-diameter, 100-foot-long pipe) and through a portion of a wetland (30-inch diameter) within the ravine downstream of Main Street. A pool has formed at the downstream end of this wetland culvert. A short distance upstream, below the Main Street culvert (24-inch diameter, 170-foot-long pipe), a large scour pool has formed. At the time of our reconnaissance survey, the upstream end of the Main Street culvert was partially clogged. The channel reappears on the south side of Main Street near the northwest corner of Yost Park. The open channel continues for a few hundred feet through a wooded area that connects to Yost Park. Although the channel is largely undisturbed in the reaches above Main Street, a few structures have been placed in or over the stream. The most significant structure is a 3-foot-high cement weir that was constructed across the channel, apparently to supply creek water (via pipe) to a small reservoir/pool immediately downstream. A significant amount of sand and gravel has accumulated behind the weir, and there is evidence of channel scour around both ends of the wall. Above the weir up to the first footbridge, the channel has a slightly lower gradient (<3 percent) and is largely unconfined. Wetlands are found on both sides of the stream. Continuing upstream through the park the gradient generally increases and the channel becomes more confined in places. Large woody debris is present in various locations throughout the park reach. Farther upstream, past the eastern boundary of Yost Park to the headwaters, Shell Creek again shows the typical characteristics of the urban/residential stream channel.

Water Quality

No published water quality data are available for Shell Creek and no water quality sampling was conducted for this stream inventory. In general (and as is the case for all of the largely urbanized streams included in this inventory), water quality in Shell Creek is potentially affected by sedimentation and inputs of chemical contaminants. We have no specific evidence to suggest that levels of chemical contaminants have had significant long-term impacts to aquatic life in

Shell Creek. Riparian canopy coverage is sparse along developed portions of Shell Creek. While this condition may contribute to elevated water temperatures during summer months, no temperature data exist to confirm this.

Fish Use and Habitat Assessment

The present survey assessed current fish habitat conditions within Shell Creek; however, no fish sampling was conducted. When contacted, WDFW indicated it has not conducted any recent fish surveys in Shell Creek (Pentico, E., WDFW, personal communication, January 22, 2002). As described above, the survey crew did observe six salmon carcasses during the reconnaissance survey in late November, indicating recent spawning activity in lower Shell Creek. The carcasses that could be identified appeared to be those of chum salmon. Other Pentec biologists have reported seeing both coho and chum salmon spawning in lower Shell Creek in recent years (Houghton, J., Pentec Environmental, personal communication, December 2001; Pentec 2000). We did not see any evidence of spawning activity upstream of here; however, Don Fiene, City of Edmonds Assistant City Engineer, told us that he has observed salmon carcasses just downstream of Caspers Street (Feine, D., City of Edmonds, personal communication, May 2002).

In the absence of any physical restriction on upstream movement past the Strickland property, the available information indicates that spawning habitat quality in the reaches immediately upstream of Caspers Street may be severely impacted by high flows/flooding and sedimentation. Access to potential spawning areas farther upstream (i.e., above Caspers Street) is limited because of other instream barriers (mainly culverts). However, area residents have reportedly observed salmon well upstream of Caspers Street (Feine, D., City of Edmonds, personal communication, May 2002). On the other hand, one long-time resident we spoke with whose property borders Shell Creek near the Daley Street culvert told our field crew he has not seen salmon in that section of the creek in the past 18 years (Mattson, K., personal communication, November 2001). Although the reported spawning distribution (i.e., upstream extent) of chum and coho salmon in Shell Creek may vary depending upon the source, there is no evidence to suggest that chinook salmon ever spawned in Shell Creek.

While anadromous fish spawning is apparently limited to the lower reaches of Shell Creek (i.e., below Daley Street), resident cutthroat are likely distributed throughout many sections of the creek, particularly those reaches that contain instream cover and pool habitat. As described elsewhere in this report, due to lack of suitable habitat, it is highly unlikely that either the anadromous or resident forms of bull trout are found in this stream system.

Recommendations

Fish Habitat Improvements

Salmon spawning and rearing habitat in the lower reaches of Shell Creek has greatly benefited from the stormwater diversion constructed at Daley Street, and from bank-stabilization structures placed upstream (i.e., Sprague Street to Main Street). Recommendations for such improvements were presented in the Shell Creek Basin report (URS 1987). In addition to surface and stormwater improvements, which are the basis for any long-term or sustained improvements to fish habitat in any of the City's streams, other significant habitat improvements that would enhance spawning and rearing habitat in the lower reaches include:

- Placement of bioengineered structures to create pools and provide instream cover in the reaches upstream from the Strickland property to Daley Street, and
- Removal of invasive plants (primarily Himalayan blackberry) and planting of native species to enhance riparian habitat and improve function.

Due to limited access (because properties were mainly residential) in the lower reaches (i.e., mainly residential properties) the opportunities for riparian habitat restoration and enhancement would largely rest with the residents whose properties border the stream. These residents could be the target of a focused public outreach effort designed to teach individuals about the value of maintaining or enhancing riparian habitat on their properties. This effort could include providing information (e.g., via flyers or brochures) regarding the use of environmentally sound landscaping materials and techniques, such as the use of native plants and trees, and alternatives to streambank armoring. Other information provided could include guidelines for the proper use of fertilizers and other chemicals. The goal would be to convince enough individual landowners that their cumulative efforts would have a significant positive effect on stream health and fish productivity. Additional information and guidance on such community efforts may be available through Snohomish County's Watershed Stewardship Program and Adopt-A-Stream (as previously discussed for Perrinville Creek).

Fish Passage Improvements

While it may not fully restrict adult salmon passage under the current conditions, redesign (e.g., decreasing the depth) or removal of the fence extending across the channel at the Strickland property would allow adult salmon unimpeded access stream to reaches upstream, including the reach between Caspers Street

and 7th Avenue N, and the mouth of Hindley Creek. Providing improved access above 7th Avenue N would likely require replacement of the 24-inch culvert there with an open-bottom culvert (or other significant improvement).

Farther upstream, the culvert under Main Street near the northwest corner of Yost Park could be improved (either replaced with a larger pipe culvert or an arch culvert) to eliminate the current restriction here that results in the accumulation of sediments and debris that partially block the existing culvert.

Within Yost Park, the fish barrier created by the concrete weir across the channel could be removed to eliminate the 3-foot vertical drop.

Hindley Creek

Hindley Creek is a Category 2 stream that receives runoff from the 178-acre Hindley Creek drainage basin. The stream corridor is almost entirely Urban/Residential (Figure 4). As previously described, Hindley Creek is the primary tributary of Shell Creek, which it enters at approximately 1,100 feet upstream from the mouth.

Hindley Creek begins with stormwater input and groundwater seepage along the hillside east of Olympic Avenue N. The main channel begins to the west of Olympic Avenue N and flows to the north-northwest through a residential area between Olympic Avenue N and 10th Avenue N. Turning west, Hindley Creek runs through culverts beneath portions of the Edmonds Elementary playfield and Saint Peter's Lutheran Church before crossing 9th Avenue N. The creek continues west, parallel to Hindley Lane, then crosses Brookmere Drive before joining Shell Creek.

Previous Studies

Stream conditions and specific problems associated with Hindley Creek were previously addressed in the Shell Creek Basin Study (URS 1987). The main problems identified in the study included flooding, erosion, and sedimentation, with some residents reporting isolated mudslides and basement flooding. As is the situation elsewhere within the City's stream basins, most of these problems can be attributed to urban/residential development that has resulted in increased surface water runoff and more sediment inputs that combine to decrease stream channel capacity. With a reduced channel capacity, the stream velocities increase and the result is more erosion and sedimentation problems. In response to these problems, the City in 1990 installed a diversion in lower Hindley Creek (along Hindley Lane) designed to intercept and reroute storm flows from the stream channel. The Hindley Creek diversion joins the Shell

Creek Diversion pipeline at 8th Avenue. The 1987 basin study did not provide specific fish habitat or fish usage information for Hindley Creek.

Stream Conditions

Approximately 100 feet from its confluence with Shell Creek, Hindley Creek passes beneath Brookmere Drive through a 24-inch by 75-foot-long culvert (Figure 4). A large pool has formed below this culvert and two small fish (i.e., 2 to 3 inches in length) were briefly observed in the pool at the time of our reconnaissance survey (i.e., late November). We could not positively identify these fish but believe they may have been resident cutthroat. A short distance upstream of the first culvert, a second 24-inch culvert runs beneath Brookmere Drive (at a bend in the road). The open channel in this reach has been extensively modified with riprap, and check dams have been placed within the channel. Over the years, residents have placed pumps behind the dams to irrigate their lawns and gardens. Relatively little streamside vegetation has been left in this area. There was also evidence of yard waste dumped along the streambank. Approximately 100 to 150 feet upstream from Brookmere Drive, a 9-foot-high concrete dam with a footbridge was constructed across the channel (Photo H-1). Although we do not know the year it was constructed, the dam is obviously very old. Due to its height, the dam is a complete barrier to the upstream passage of fish. A pool was formed on the upstream side of the dam after its construction; however, it has since filled with sediments and other debris that has washed down the channel.

Representative stream channel measurements were taken just upstream of a 24-inch driveway culvert near the intersection of 8th Avenue N and Hindley Lane (Figure 4). The stream channel here is mostly confined as a result of the riprap that lines the majority of the channel length. The channel is relatively flat, with a gradient from 1 to 2 percent (Table 2). The substrate is predominantly sand with embedded gravels (unsuitable for spawning). Streamside vegetation is sparse and largely devoid of vegetation that would provide significant shading.

Farther upstream, parallel to Hindley Lane, the channel gradient increases to 3 to 5 percent as the stream passes through the yards and beneath the driveways of the houses that border the south side of the street (Photos H-2 and H-3).

Above this reach, the stream flows through a culvert that runs beneath 9th Avenue N and a portion of the Saint Peter's Lutheran Church property on the uphill side (a distance of approximately 250 feet). Upstream of the culvert, within the Church property, the open channel displays characteristics that are more representative of a residential ravine (Figure 4). This includes less channel armoring/hardening and a larger buffer. Streambank vegetation observed along

this reach included reed canarygrass, salmonberry, Himalayan blackberry, English ivy, and willow. There also was evidence of bank erosion/scour at a bend at the upstream end of the culvert (Photo H-4).

Continuing upstream of this open reach, Hindley Creek flows through another long culvert that runs beneath the southwest corner of the Edmonds Elementary playfield and daylights above Viewland Way. Upstream of Viewland Way the stream passes through a residential area, with channel characteristics very similar to those observed along Hindley Lane (i.e., Urban/Residential) (Photo H-5). The (mostly) open channel continues upstream between 10th Avenue N and Olympic Avenue N, where it eventually connects with the storm drain system (Photo H-6).

Water Quality

As a result of stormwater runoff, water quality in Hindley Creek is likely affected by both turbidity and inputs of chemical contaminants, such as oil and grease from road surfaces. Potential contamination sources also include the overapplication/misuse of fertilizers and pesticides by property owners, and illegal dumping of used oil and other wastes into storm drains or directly into the stream itself. In addition, water temperatures in Hindley Creek may become elevated during the summer months due to lack of adequate riparian canopy to shade the stream.

No published water quality data are available for Hindley Creek and no water quality sampling was conducted for this stream inventory. Our assessment is based on the previous basin studies, and observed channel conditions and riparian conditions in the current survey. We have no specific evidence to suggest that impacts to water quality have had significant long-term impacts to aquatic life in Hindley Creek.

Fish Use and Habitat Assessment

The present survey assessed current fish habitat conditions within Hindley Creek; however, no fish sampling was conducted. WDFW has not conducted any fish surveys in Hindley Creek (Pentico, E., WDFW, personal communication, January 22, 2002). Although salmon spawning (i.e., chum and coho salmon) has been observed in lower Shell Creek (see above), we found no reports of adult salmon in Hindley Creek. As noted in the results of our reconnaissance survey, small fish, possibly resident cutthroat, were observed in a pool formed below the first culvert on Hindley Creek near its confluence with Shell Creek. In the absence of

any restrictions in lower Shell Creek below the confluence, adult salmon could potentially move upstream into lower Hindley Creek, and possibly as far upstream as the impassable dam structure near Hindley Lane. However, because of the extensive channel modifications here (including 24-inch-diameter culverts) and overall lack of suitable spawning habitat, it is unlikely that adult fish would use this reach under present conditions. Again, it is very unlikely that either chinook salmon or bull trout have ever spawned in this stream system. Currently, resident species (e.g., cutthroat) may move between Shell Creek and portions of lower Hindley Creek, although instream cover and pool habitat is very limited.

Recommendations

Fish Habitat Improvements

As discussed above, existing salmon spawning and rearing habitat in the lower reaches of Hindley Creek is currently very limited. Similar to Shell Creek, fish habitat in Hindley Creek would be improved through stream channel and riparian buffer enhancements (discussed above).

Fish Passage Improvements

Assuming fish passage improvements were first made in lower Shell Creek, the initial fish passage improvements in Hindley Creek would be replacing the two 24-inch culverts that run beneath Brookmere Drive with larger, open-bottom culverts. This would allow unimpeded access beyond just the mouth of the stream. Continuing upstream, the next obvious target for improvement is the dam, which is now a complete barrier to upstream fish passage. This would be either complete removal of the dam or construction of a ladder. Both projects would involve significant costs (which is generally the case for most of the passage improvements discussed here). Assuming, however, that costs and property ownership issues were not the deciding factors, there would still be the significant engineering difficulties associated with both projects to consider. In many respects, complete removal of the dam might be more problematic because of the extensive channel grading and streambank stabilization that would be required. However, once completed there would not be the periodic maintenance requirements that a fish ladder would require.

Fish passage improvements become less of a priority above the dam. Fish passage beyond the reach below 9th Avenue N would require replacement/removal of approximately 250 feet of culvert that extends upstream through a portion of the Saint Peter's Lutheran Church property. The costs associated with this project would also be very significant. These fish passage improvements

would not address the erosion and sedimentation problems that affect habitat quality in the lower reaches.

Shellabarger Creek

The Shellabarger Creek drainage basin (354 acres) includes Shellabarger Creek, a relatively short Category 2 stream that originates from groundwater in a residential area near 8th Avenue and Elm Street (Figure 5). The multiple channels combine between 5th Avenue and 6th Avenue to form the main channel of Shellabarger Creek. The stream continues downslope, crossing under 5th Avenue and 3rd Avenue before reaching the edge of Union Oil Marsh on the east side of Sunset Avenue (SR 104). From here, the channel crosses beneath SR 104 and winds through the freshwater wetlands of the Union Oil Marsh, where it enters Willow Creek.

Previous Studies

Surface water and stormwater drainage and water quality problems in the Shellabarger Basin were addressed in the 1989 Edmonds Drainage Basin Studies report (URS 1989). The report documented existing problems in Shellabarger Creek and tributaries that included:

- Steam channel erosion resulting from high velocities (i.e., exceeding 5 feet per second) during storm events;
- Inadequate culvert/culvert opening capacity resulting in upstream flooding; and
- Impacts to water quality from oil pollution (e.g., on road surfaces and illegal dumping) and high nutrient loading from overuse of fertilizers.

The basin study provided recommended solutions that included:

- Install check dams to reduce slope (and velocity);
- Redesign openings to problem culverts or replace existing pipes with larger-diameter pipes; and
- Educate residents on toxic effects of petroleum products and the proper use of fertilizers.

No specific information on aquatic habitat (including fish use) was provided in the basin report.

Habitat conditions within the lower reaches of Shellabarger Creek were addressed in the SR 104 Edmonds Crossing Draft Environmental Impact Statement [DEIS] (City of Edmonds 1998) and in the Evaluation of Habitat Benefits and Impacts Associated with the Proposed Daylighting of the Outlet from Edmonds Marsh (Pentec 1998).

Stream Conditions

Progressing upstream from the confluence with Willow Creek, Shellabarger Creek flows through the freshwater wetlands on the west side of SR 104. About midway between Pine Street and Dayton Street the creek crosses under SR 104 through a 48-inch culvert, and continues in a southerly direction along the east side of the highway (Photo SB-1). From here the creek turns due east, running for a short distance (<200 feet) through a forested area consisting of red alder and big-leaf maple, with an understory of primarily Himalayan blackberry. The creek continues upward for approximately 300 feet within a shallow ravine adjacent to an apartment building, and then underneath 3rd Avenue through a 30-inch by 40-foot-long culvert. On the opposite side the creek continues uphill within a ravine between 3rd and 5th Avenues. Riparian vegetation in this section includes mostly blackberry and various other shrubs.

Our reconnaissance survey in early December happened to coincide with a City water-line break near 3rd Avenue. The result was turbid streamflows as water ran off the surface near the pipeline rupture and washed surrounding soil into the channel (Photos SB-2 and SB-3).

At the top of the ravine the creek disappears into a long (550-foot) 36-inch culvert that runs beneath 5th Avenue and an adjacent parking lot. At the time of our survey, the entrance to the culvert above 5th Avenue was partially blocked with debris that appeared to have been left after a previous storm event (Photo SB-4). The creek continues upward within a ravine past single-family homes (Photo SB-5). The banks of the ravine were covered with vegetation; mostly non-native species, but some native plants (e.g., ferns, salmonberry), were present (Photo SB-6). The stream channel in this segment contains some pools, but LWD is scarce (Table 2). The substrate is primarily gravel (Photo SB-7).

At the upper end of the ravine near Homeland Drive, the main channel splits. The north channel is heavily modified and displays those characteristics typically associated with Urban/Residential-type streams (Photos SB-8 and SB-9). The south channel continues for a short distance through a heavily overgrown ravine before it also changes to an Urban/Residential-type channel within the headwaters (Photo SB-10).

Water Quality

Like all of the streams addressed in this inventory, water quality in Shellabarger Creek is potentially affected by increased turbidity and inputs of chemical contaminants resulting from stormwater runoff in the basin. The over-application/misuse of fertilizers and pesticides by homeowners may also affect water quality. In addition, water temperatures in Shellabarger Creek may become significantly elevated during low-flow conditions in the summer.

No water quality sampling of Shellabarger Creek was conducted as part of this inventory and no other sources of existing quantitative data were identified. Therefore, there is insufficient information to determine whether impacts to water quality have had significant long-term adverse affects on aquatic life in Shellabarger Creek, lower Willow Creek, or the Union Oil Marsh.

Fish Use and Habitat Assessment

No fish sampling was conducted in Shellabarger Creek as part of the current inventory and WDFW has not conducted any recent fish surveys here (Pentico, E., WDFW, personal communication, January 22, 2002). Like most of the City's streams, resident cutthroat probably exist in some portions of Shellabarger Creek. Because of its connection to Willow Creek, anadromous fish (coho and sea-run cutthroat) have access to the lower reaches of Shellabarger Creek up to the culvert at 3rd Avenue (see Willow Creek; Fish Use and Habitat Assessment). As described above, there is a general lack of suitable spawning and rearing habitat within the marsh reach from the confluence with Willow Creek extending upstream to the point where the channel exits the marsh on the east side of SR 104. Farther upstream there is suitable rearing and spawning habitat provided by the coarse sand and gravel substrate, instream structures, pool habitat, and adequate shade. However, Shellabarger Creek does not provide suitable habitat for chinook salmon and bull trout.

The culvert beneath 3rd Avenue is likely an impassable barrier to salmonids due to high velocities caused by the slope and depth of water in the culvert. Even if fish were able to pass through this culvert under optimal conditions, the very long (550-foot) culvert beneath 5th Avenue would certainly be a barrier to fish passage. The basin report indicated velocities within the pipe have been measured as high as 15 feet per second (URS 1989).

Recommendations

Fish Habitat Improvements

There are some fish habitat restoration possibilities in the lower reach of Shellabarger Creek. Fish habitat within the stream could be improved by regrading the existing channel in selected locations and by adding bioengineered structures (e.g., LWD) to help stabilize the channel and create pool habitat. Riparian buffers could be improved substantially by removal of invasive species and planting of native shrubs and trees.

As we have emphasized repeatedly throughout this habitat assessment, improved stormwater controls within the basin are necessary to sustain anadromous fish runs.

Fish Passage Improvements

Under present conditions, there is very limited habitat in the reach between 3rd Avenue and 5th Avenue. Therefore, significant habitat improvements would also need to be made here to obtain real benefits from replacement of the existing culvert beneath 3rd Avenue with an open-bottom culvert or other design to allow fish passage. Replacement of the culvert beneath 5th Avenue would involve substantially higher design and construction costs and would provide relatively little benefit. Fish passage improvements in Willow Creek should be prioritized above this potential improvement.

Willow Creek

Willow Creek is an anadromous-fish-bearing Category 2 stream that drains approximately 343 acres within the Edmonds Way Basin (Figure 5). From its headwaters along the hillside in south Edmonds, the stream crosses underneath SR 104 and Woodway Park Road before turning to the north where it crosses Pine Street and enters the Union Oil Marsh. At approximately 23 acres, the Union Oil Marsh is the largest remaining shoreline wetland within the greater Edmonds area. It consists primarily of a freshwater wetland with a smaller saltmarsh along its western edge, nearest to the Puget Sound shoreline. The Willow Creek channel becomes a ditch where it runs along the marsh edge, and connects the marsh with Puget Sound through a series of culverts.

Previous Studies

As a primary drainage feature of the Edmonds Way Basin, Willow Creek was included in the City of Edmonds Drainage Basin Studies, Edmonds Way,

Perrinville, and Meadowdale (R.W. Beck 1991). The study addressed surface water management within the basin and examined closely the surface water drainage system. The management program emphasized water quality, as well as the preservation and enhancement of wetlands, riparian corridors, and fisheries. The results of a fish habitat survey for Willow Creek were included in the 1991 basin study. These results are summarized below.

Conditions within the lower reach of Willow Creek were also addressed in the SR 104 Edmonds Crossing DEIS (City of Edmonds 1998).

In 1998, Pentec conducted an evaluation of habitat benefits and impacts associated with a proposal to daylight the outlet from the Union Oil Marsh to Puget Sound. In addition to improving access to the marsh by anadromous fish, the proposal would increase the exchange of water between the marsh and Puget Sound. Although a tide gate at the culvert has been removed (in 1989), creation of an open channel would significantly expand the area of saltmarsh and would help to restore some of the estuarine functions of the marsh that were initially lost upon construction of the railroad along the Puget Sound shoreline.

Stream Conditions

A detailed description of the existing habitat conditions along the lower reaches of Willow Creek was presented in the Evaluation of Habitat Benefits and Impacts Associated with the Proposed Daylighting of the Outlet from Edmonds Marsh (Pentec 1998). Overall habitat conditions in Willow Creek are expected to have changed very little over the 3-year period between the fall 1998 survey and the current stream inventory. Therefore, we have based our current assessment of fish habitat conditions on the results of the earlier field study.

In summary, the creek is very channelized through most of the marsh area and there is generally insufficient vegetation to provide adequate shading, particularly in the lower segment (Photos W-1, W-2, and W-3). Substrate in the channelized section is predominantly fine silt and intertidal mud (W-4). A short distance below the confluence with Shellabarger Creek, the channel becomes highly braided. Riparian cover is abundant in this braided section and dense aquatic vegetation provides instream cover; however, there is no LWD (Photo W-5). The dense vegetation also tends to trap fine sediments, which accumulate here.

Within a few hundred feet upstream the gradient increases and there is a more defined channel that contains small to medium wood debris and larger substrate (predominantly sand with small gravels). A dense overstory of red alder, western

red cedar, and big-leaf maple, along with an understory of salmonberry, provides abundant shade (Photo W-6).

Continuing upstream, Willow Creek passes through the Deer Creek Hatchery located on the north side of Pine Street, near the intersection of Pine Street and SR 104. The channel arcs around the hatchery to the southeast, proceeding up through a turbulent cascade reach lacking in pools, through a weir, and then through a 145-foot-long culvert beneath Pine Street.

Above Pine Street, the creek channel continues uphill with a moderate gradient of 2 to 4 percent through a dense stand of red alder and salmonberry. Gravels are abundant, although poorly sorted, in most of the reach, with moderate to high amounts of sand embeddedness (Photo W-7). An impassable falls exists approximately 400 feet above Pine Street (Photo W-8). The channel displays similar characteristics as it continues uphill through a wooded area past Elm Street and Woodway Park Road (Photo W-9).

Water Quality

No water quality sampling in Willow Creek was conducted as part of this survey and no other sources of existing quantitative data were identified. The water quality issues that affect the other streams included in this survey apply to Willow Creek as well. This primarily includes inputs of oil and grease from road surfaces and illegal dumping, and fertilizers and pesticides through overuse and misapplication. We have no specific evidence to suggest that levels of these potential contaminants have had significant long-term impacts to aquatic life in Willow Creek, or to the Union Oil Marsh.

As previously described, during the summer months water temperatures in the exposed lower reaches, particularly in the channelized section, likely become elevated from lack of shade. These warmer temperatures can result in lower dissolved oxygen levels.

Fish Use and Habitat Assessment

The privately run Deer Creek Hatchery produces coho salmon, which are reared at the facility for outplanting in other basins. Despite the difficulties associated with upstream migration past the long culvert at the marsh outlet, navigation through the marsh, and upstream passage through the culvert that runs beneath Pine Street, some adult coho do return to the hatchery. These fish presumably have matured from fry accidentally released from the hatchery, as no successful natural spawning has been reported in the system (Pentec 1998). A weir placed

in the channel at the hatchery prevents upstream migration during the rearing season, but this is removed during the time fish are not rearing at the hatchery.

In addition to coho salmon, cutthroat (presumably both resident and anadromous forms) have been reported in Willow Creek (Schneider, P., WDFW, personal communication, December 3, 1990). WDFW has not conducted any recent fish surveys in this stream (Pentico, E., WDFW, personal communication, January 22, 2002). However, the 1998 stream habitat survey verified the presence of resident cutthroat above Pine Street (Photo W-10). No fish sampling was conducted as part of the current inventory.

As described in the 1998 stream habitat survey, the highly channelized and mostly exposed lower reaches located within the marsh provide little spawning and rearing habitat for salmonids. Continuing upstream, the braided channel reach below the hatchery provides rearing habitat, but generally lacks adequate suitable spawning gravels. The reach above Pine Street up to the impassable barrier contains enough spawning gravels to support spawning salmon. However, Willow Creek does not contain suitable spawning and rearing habitat for chinook salmon and bull trout.

Recommendations

Fish Habitat Improvements

The habitat improvements within the lower reaches of Willow Creek that would result from the proposed daylighting of the outlet from the marsh were discussed in the 1998 report. Although highly channelized, rearing habitat within the lower reach could be significantly improved with the addition of instream structures as well as enhancement of the riparian buffer.

Fish Passage Improvements

As discussed in the previous studies, daylighting the outlet from the marsh would improve access for migrating fish into the marsh and to both Willow and Shellabarger creeks. Replacement of the existing culvert beneath Pine Street would provide improved access to spawning and rearing habitat upstream of Pine Street. Removal of the barrier located approximately 400 feet upstream of Pine Street would allow access to additional habitat.

RECOMMENDATION FOR FUTURE STREAM HABITAT ASSESSMENTS AND HABITAT MONITORING

In this report we describe baseline fish habitat conditions using (1) previous information in the basin studies and other technical reports, and (2) stream/habitat surveys conducted in November and December 2001. Based on these data we have recommended fish habitat and fish passage improvements. However, as indicated throughout this document, there is currently little or no available information on streamflows and fish presence in the seven streams covered in this study. These data would have direct relevance to the City's goal of establishing baseline habitat conditions in the seven study streams. Therefore, we recommend the City consider the following two sampling and monitoring studies:

Streamflow

Purpose—Establish Seasonal Flow Rates

In order to accurately assess seasonal variations in streamflows, flow measurements need to be obtained at different times of the year. We would expect that base flows are at the lowest levels during the summer dry period (June-August). It is during this period that flows could potentially be a limiting factor in the creek's ability to support fish populations year round. There is considerable evidence that under present conditions (i.e., without adequate stormwater detention) peak flows have adversely affected fish habitat. We recommend that the City develop and implement a flow monitoring study designed to establish base-flow conditions for each of the seven streams at different times of the year (e.g., monthly or bimonthly). These data will allow accurate assessment of the potential affect of flow variations on the quality of fish habitat in each of the study streams.

Fish Sampling

Purpose—Establish Presence of Anadromous and Resident Fish Species Within Each Stream

Documented fish presence in the seven study streams is limited to a few reaches within Perrinville Creek, Shell Creek, and Willow Creek. In addition to the salmon carcasses observed in Shell Creek in the current survey, we also observed fish (possibly juvenile resident cutthroat) in Northstream and Hindley Creek. Previous fish habitat surveys have been cited in the literature (Fruitdale and Northstream surveyed in 1985), but no fish were reported and no information is available to describe the specific survey timing or methods used

to sample the streams. Therefore, present fish distribution in the study streams can only be estimated.

In order to positively establish the presence and distribution of fish species in each stream (particularly in relation to streamflows and stream habitat conditions), we recommend the City develop and implement a fish survey. This survey will require a sampling permit from WDFW, which may restrict the sampling equipment used and/or the timing of the survey(s). Because WDFW has not conducted any recent fish surveys in any of seven study streams (Pentico, E., WDFW, personal communication, January 22, 2002), the agency may be supportive of such a sampling effort, which would provide useful information that could be added to the statewide Priority Species and Habitats database.

REFERENCES

City of Edmonds, 1998. SR 104 Edmonds Crossing Draft Environmental Impact Statement and Draft Section 4(f) Evaluation. U.S. Department of Transportation Federal Highway Administration, Washington State Department of Transportation, and City of Edmonds, Washington.

NMFS (National Marine Fisheries Service), 1999. The Habitat Approach. Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. NMFS, NW Region, Habitat Conservation and Protected Resources Divisions, Portland, Oregon.

Pentec (Pentec Environmental, Inc.), 1998. Evaluation of Habitat Benefits and Impacts Associated with the Proposed Daylighting of the Outlet from Edmonds Marsh. Prepared for the Port of Edmonds, Washington, by Pentec, Edmonds, Washington.

Pentec (Pentec Environmental), 2000. Strickland Critical Areas Study. Prepared for R.T. Strickland by Pentec, Edmonds, Washington.

Pentec (Pentec Environmental, Inc.) and Shannon & Wilson, Inc., 1998. Perrinville Creek Streambank Stabilization, Final Report. Prepared for the City of Edmonds, Washington, by Pentec, Edmonds, Washington, and Shannon & Wilson, Inc., Seattle, Washington.

R.W. Beck, 1991. Edmonds Drainage Basin Studies: Edmonds Way, Perrinville, and Meadowdale Basins. Prepared for City of Edmonds, Washington, Community Services Department, and Snohomish County Department of Public

Works, Everett, Washington, by R.W. Beck and Associates, Inc., Seattle, Washington.

URS (URS Corporation), 1987. Shell Creek Basin Study. Prepared for the City of Edmonds, Washington, Community Services Department, by URS, Seattle, Washington.

URS (URS Consultants), 1989. Edmonds Drainage Basin Studies—Shellabarger, Five Corners, North Stream, Talbot Park Basins. Prepared for City of Edmonds, Washington, Community Services Department, by URS Consultants, Seattle, Washington.

WDNR (Washington State Department of Natural Resources), 1997. Standard Methodology for Conducting Watershed Analysis Under Chapter 222-22 WAC, Version 4.0. Timber/Fish/Wildlife Agreement and WDNR, Olympia.

TABLES

Table 1 - Qualitative Descriptions of Representative Reach Types Found in Edmonds Watersheds

Reach Type	General Description	Gradient (percent)	Flow Type (primary)	Urbanization	Stream/Location
Park Reach (Southwest County)	Low to moderate gradient and larger channel migration zone, including braided channel in some places. Mostly depositional. LWD present throughout. Riparian buffer contains some invasive/non-native species.	2-5	Riffle	None	Perrinville Creek-Upper reach within Southwest County Park
Park Reach (Yost and Maplewood)	Channel confinement and gradient varies. Moderate amounts of wood debris in stream. Generally good riparian buffer provides adequate shading.	3-5	Step-riffle/Riffle	None	Upper ends of Northstream and Shell Creek
Residential/Ravine	Mostly confined channel with slope instability in places with evidence of scour (e.g., Perrinville Creek). LWD present, but usually in low quantity. Generally few channel modifications; relatively little streambank hardening. Riparian buffer present, but usually composed primarily of invasive species (e.g., Himalayan blackberry).	3-8	Riffle	Development often extends close to edge of slope; culverts are present.	Perrinville Creek, Fruitdale Creek, Shell Creek, Shellabarger Creek, Willow Creek, and Northstream
Urban/Residential	Typically low-gradient channel, with extensive modifications; often hardened with riprap or concrete. Minimal amounts of woody debris present; trash and other debris (e.g., yard waste) sometimes dumped along banks and into channel. Minimal stream buffer provides little or no shading; invasive species common. Extensive landscaping, particularly within residential neighborhoods.	<3	Riffle or pool-riffle	Extensive development within stream corridor; culverts are present.	Fruitdale Creek, Shell Creek, Shellabarger Creek, Willow Creek, and Northstream
Mouth/Lower Reach - Developed	Usually a single, often extensively modified channel. Modifications include channel hardening, placement of weirs and other dam structures, and sometimes intakes for irrigation systems. Clearing or landscaped yards provide little or no stream buffer.	3-5	Riffle	Stream corridor is mostly developed.	Perrinville Creek, Fruitdale Creek, Shell Creek, Shellabarger Creek, Willow Creek, and Northstream
Mouth/Lower Reach - Undeveloped	Located within a large privately owned property along the mouth of Shell Creek. The stream is associated with a large wetland and riparian buffer. Contains a low-gradient channel with few modifications; channel is braided throughout property. Recent spawning activity here.	<3	Riffle	None	Shell Creek

Channel Measurements					Terrace Height (m)		Disturbance (%)	Pool Data		Veg. Types
Bankfull Width (feet)	Bankfull Depth (feet)	Floodprone Width (feet)	Gradient (%)	Channel Confinement	Left Bank	Right Bank		% Pools per Subsegment	% Pools per Reach	
7.1	1.2	52.9	3	U	-	-	0	15		Herbs
9.7	2.1	15.2	4.5	C	-	-	12	5	10	Herbs
-	-	-	-	-	-	-	80	8		Shrubs
5.2	0.6	5.2	2	C	-	-	0	7		Shrubs
15.1	1.8	16.3	5	C	-	-	20	18	12	Shrubs
							60	11		Shrubs
12.1	2.6	27.6	3	M	-	-	20	11		Shrubs
11.7	1.7	19	5.5	C	-	-	45	10	8	Shrubs
9.8	1.8	12.9	5	C	-	-	65	2		Shrub/Tree
3.8	1.1	17.5	1	U	-	-	100	0		None
6.7	0.4	7.6	2	C	-	-	75	0	0	Herbs
4.3	0.6	8.4	2	C	-	-	50	0		Shrubs
18.4	1.4	102.5	2	U	-	-	10	21		Tree
14.4	1	24.9	2	C	-	3.6	15	13	21	Tree
13.8	1.7	34.4	2	M	3.6	3.6	30	30		Tree
13.7	2	25.4	12	C	-	-	100	3		Tree
20.5	2	26.6	5	C	-	-	100	8	7	Tree
20.9	2.1	42.6	7	M	-	-	100	12		Tree
14.2	1.5	85.1	1.5	U	-	-	0	0		Shrubs
5.4	1.8	61	1.5	U	-	-	15	0	0	Shrubs
7.3	0.5	163.7	1.5	U	-	-	10	0		Herbs

00130V014\table2_data.xls

Confinement

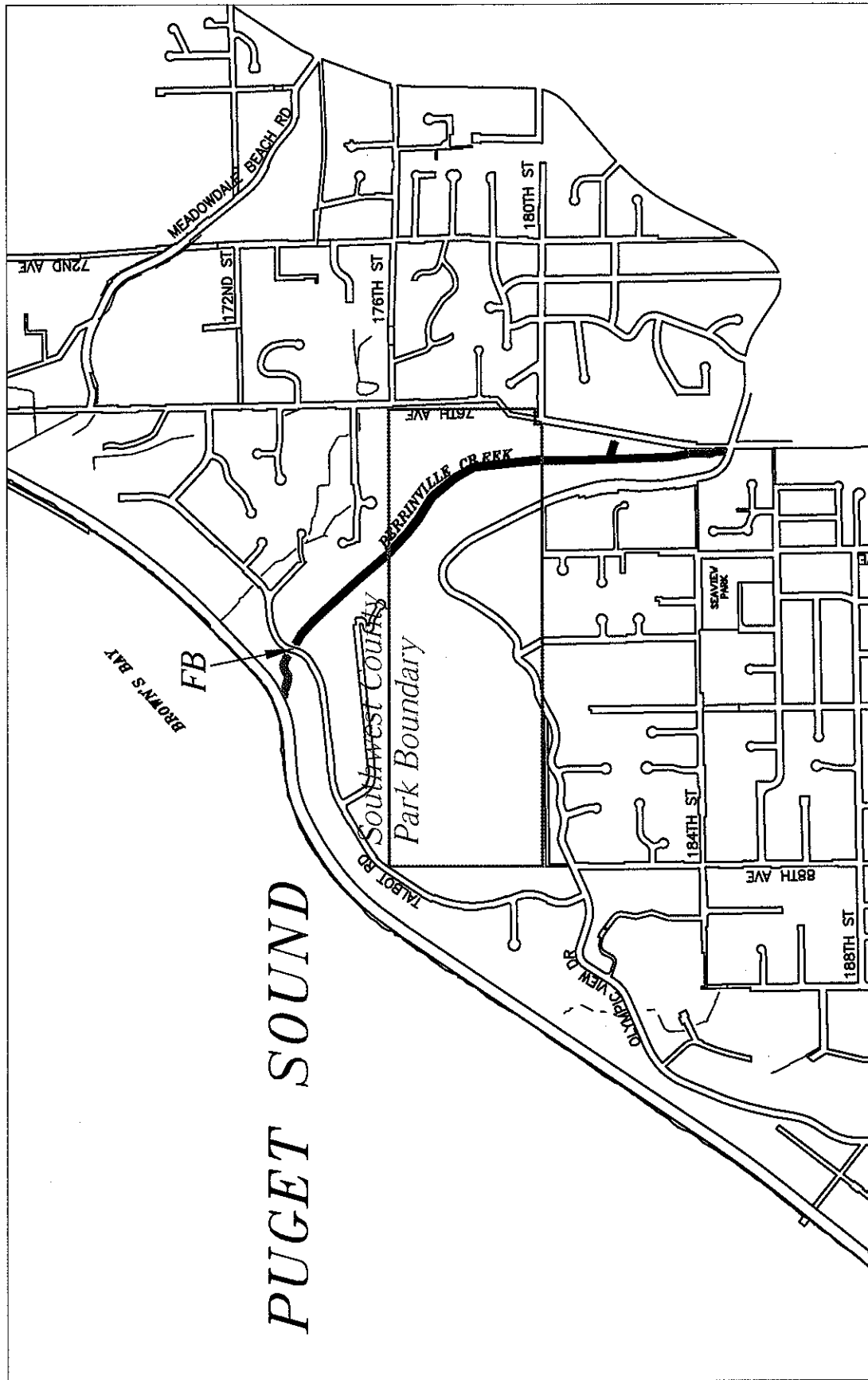
fined

onfined

ified

FIGURES

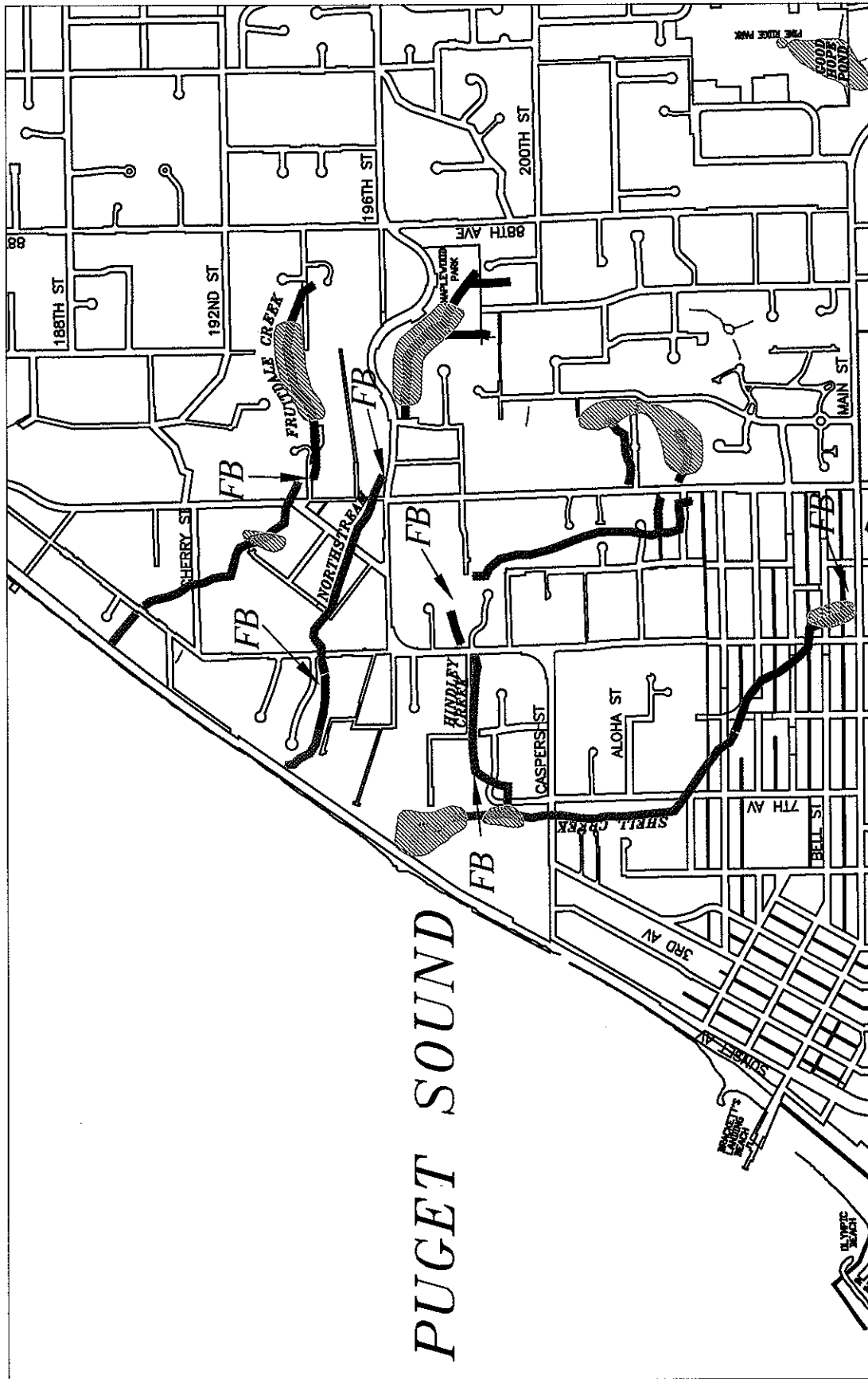
Edmonds Stream Inventory Perrinville Creek



- Developed Mouth/Lower Reach
- Undeveloped Mouth/Lower Reach
- Urban / Residential
- Residential / Ravine
- Park Reach (Maplewood/Yost)
- Park Reach (Southwest County)
- * Snohomish County Critical Areas 1991
- Wetland *
- FB = Fish Barrier



Edmonds Stream Inventory Fruitdale Creek and Northstream



GSM 1"=1300'

basinmap.dwg

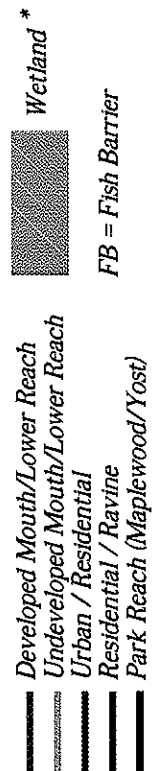
PENTEC ENVIRONMENTAL

12130-14
Figure 3

01/02/02

* Snohomish County Critical Areas 1991

PUGET SOUND



* *Snohomish County Critical Areas 1991*

APPROXIMATE SCALE IN FEET

0 650 1300 2600



GSM 1"=1300'

bsimad.pwg



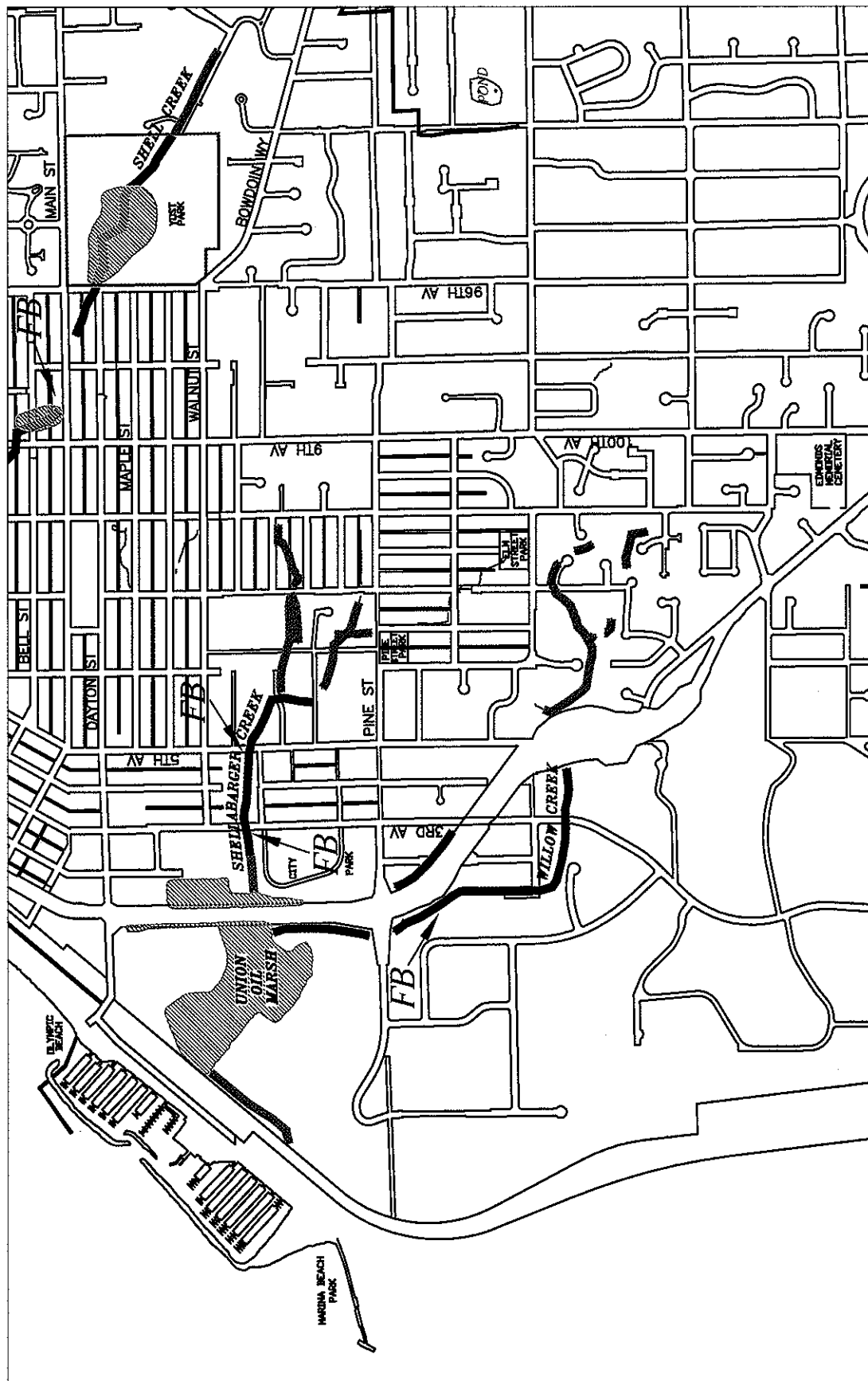
PENTAC ENVIRONMENTAL

12130-14

Figure 4

01/02/02

Edmonds Stream Inventory Shell and Willow Creeks



GSM 1"=1300'

basinmap.dwg

PENTEC ENVIRONMENTAL

12130-14
Figure 5

01/02/02

* Snohomish County Critical Areas 1991

**APPENDIX—
PHOTOGRAPHS OF SELECTED STREAMS**

PERRINVILLE CREEK



P-1 Perrinville Creek, downstream of culvert under BNRR tracks.



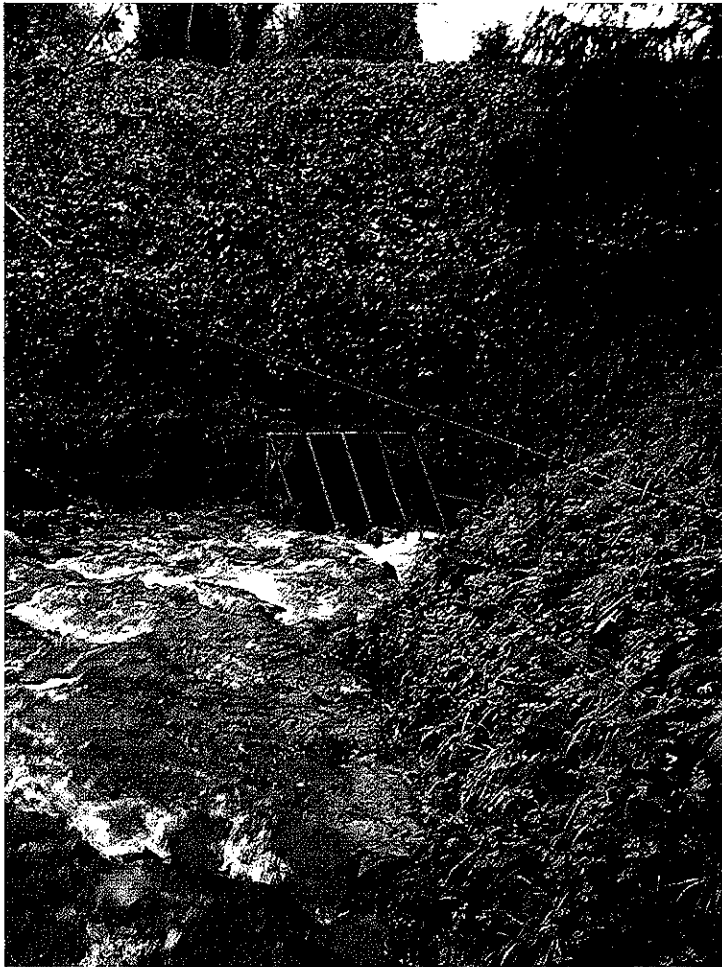
P-2 Perrinville Creek, fence across channel upstream from mouth.



P-3 Perrinville Creek stormwater overflow.



P-4 FB5 – Perrinville Creek, downstream of culvert under Talbot Road.



P-5 Inlet to culvert under Talbot Road (11/14/01).



P-6 Clogged culvert inlet at Talbot Road (12/17/01).

Perrinville Creek

Pentec Environmental
12130-14



P-7 Eroded stream channel above Talbot Road (12/17/01).



P-8 Perrinville Creek, streambank erosion in ravine.

Perrinville Creek

Pentec Environmental
12130-14



P-9 Perrinville Creek, left bank slope failure.



P-10 Perrinville Creek, streambank erosion in Southwest County Park.

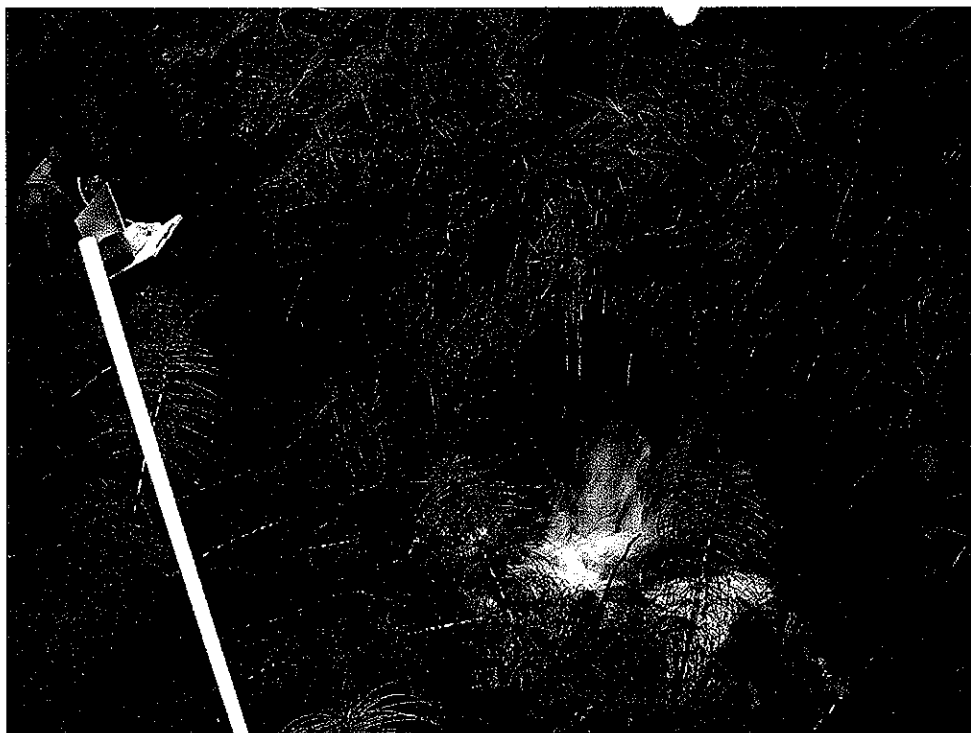


P-11 Perrinville Creek, upstream of Southwest County Park.

FRUITDALE CREEK



F-1 Fruitdale Creek, outlet of culvert under BNRR tracks.



F-2 Fruitdale Creek, culvert outlet upstream from mouth.



F-3 Fruitdale Creek, discarded tires embedded in stream channel.



F-4 Fruitdale Creek, flood control structure upstream of Sound View Place.

Fruitdale Creek

Pentec Environmental
12130-14



F-5 Fruitdale Creek, modified stream channel.



F-6 Fruitdale Creek, modified stream channel.

Fruitdale Creek

Pentec Environmental
12130-14



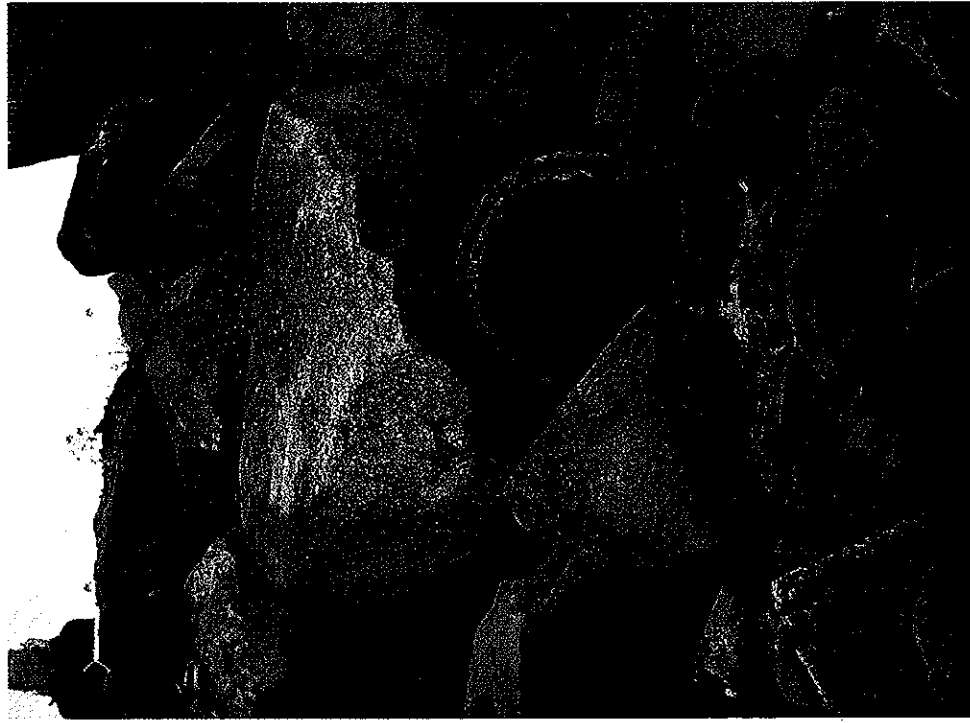
F-7 Fruitdale Creek, residential reach
upstream of Forest Dell Drive.



F-8 Fruitdale Creek, residential reach
upstream of Forest Dell Drive.

NORTHSTREAM

Northstream



N-1 Northstream, outlet of culvert under BNRR tracks.

Pentec Environmental
12130-14



N-2 Northstream, concrete-lined channel, lower reach.

Northstream

Pentec Environmental
12130-14



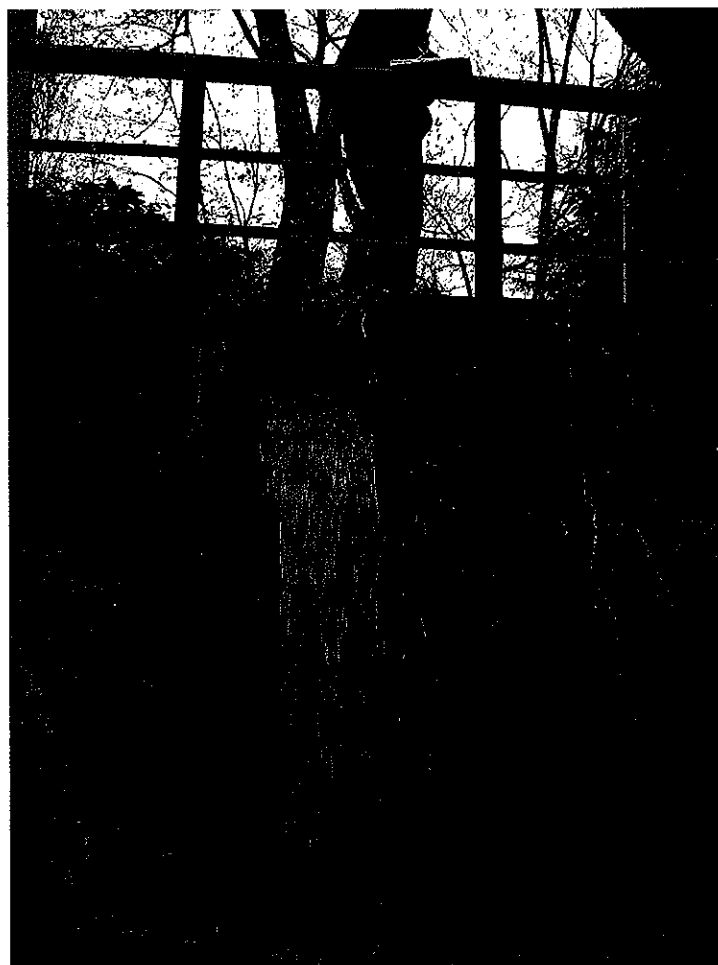
N-3 Northstream, modified channel, lower reach.



N-4 Northstream, Gates property, lower reach.



N-5 Northstream, Gates property, lower reach.



N-6 Northstream, impassable barrier, lower reach.

Northstream

Pentec Environmental
12130-14



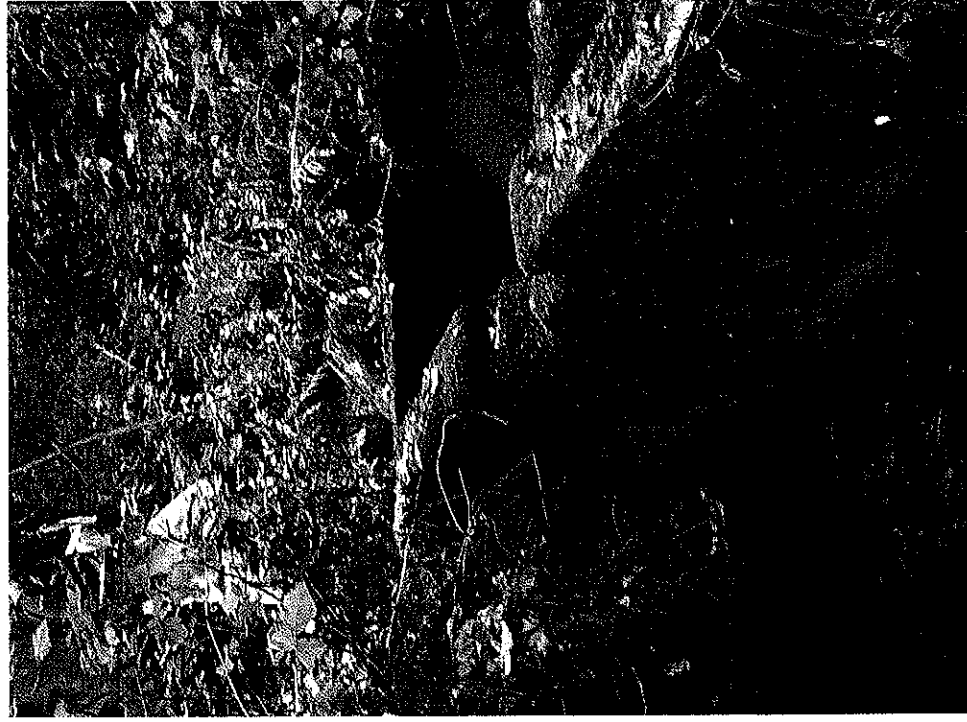
N-7 Northstream, reach, upstream of impassable barrier.



N-8 Northstream, upstream end of 12th Avenue N culvert.

Northstream

Pentec Environmental
12130-14



N-9 Northstream, concrete structure in channel upstream of 12th Avenue N.



N-10 Northstream, dense vegetation upstream of 12th Avenue N.

SHELL CREEK



S-1 Shell Creek, outlet of culvert under BNRR tracks.



S-2 Shell Creek, Strickland property.

Shell Creek

Pentec Environmental
12130-14



S-3 Shell Creek, salmon carcass (Strickland property).



S-4 Shell Creek, pond inlet (Strickland property).



S-5 Shell Creek, fence across channel.



S-6 Shell Creek, downstream view between 7th and Daley.



S-7 Shell Creek, culvert under Daley Street.

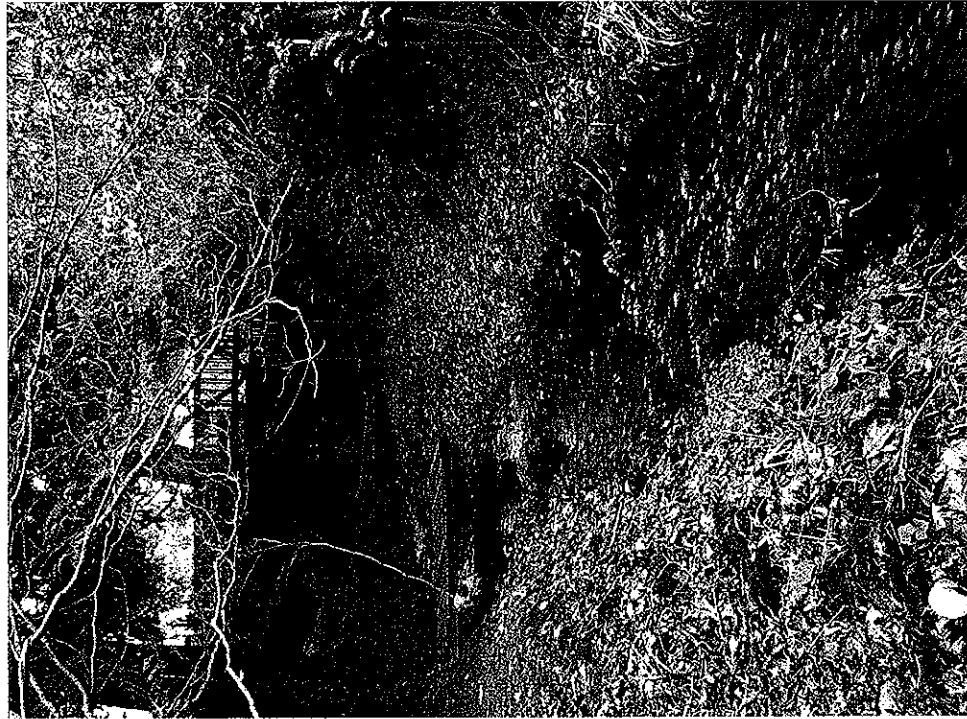


S-8 Shell Creek, upstream of Daley Street.

HINDLEY CREEK

Hindley Creek

Pentec Environmental
12130-14



H-1 Hindley Creek, impassable barrier,
upstream of Brookmere Drive.



H-2 Hindley Creek, upstream view adjacent to
Hindley Lane.

Hindley Creek

Pentec Environmental
12130-14



H-3 Hindley Creek, culvert under driveway to Hindley Lane.



H-4 Hindley Creek, bank erosion near Saint Peter's Lutheran Church.



H-5 Hindley Creek upstream of Viewland Way.



H-6 Hindley Creek, upper end of channel, upstream of 10th Avenue N.

SHELLABARGER CREEK



SB-1 Shellabarger Creek, downstream of SR 104.



SB-2 Shellabarger Creek below 3rd Avenue
(after pipe break).

Shellabarger Creek

Pentec Environmental
12130-14



SB-3 Shellabarger Creek, downstream of
3rd Avenue.



SB-4 Shellabarger Creek, partially blocked
culvert upstream of 5th Avenue.

Shellabarger Creek

Pentec Environmental
12130-14



SB-5 Shellabarger Creek, upstream view from 5th Avenue.



SB-6 Shellabarger Creek, upstream of 5th Avenue.

Shellabarger Creek



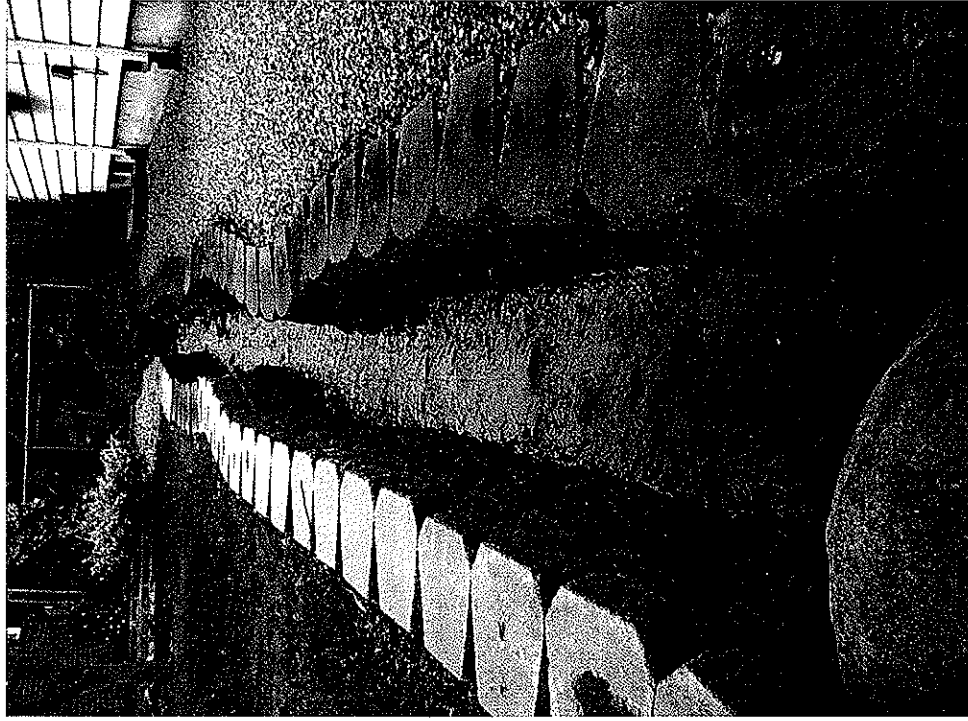
SB-7 Shellabarger Creek, gravel substrate upstream of 5th Avenue.



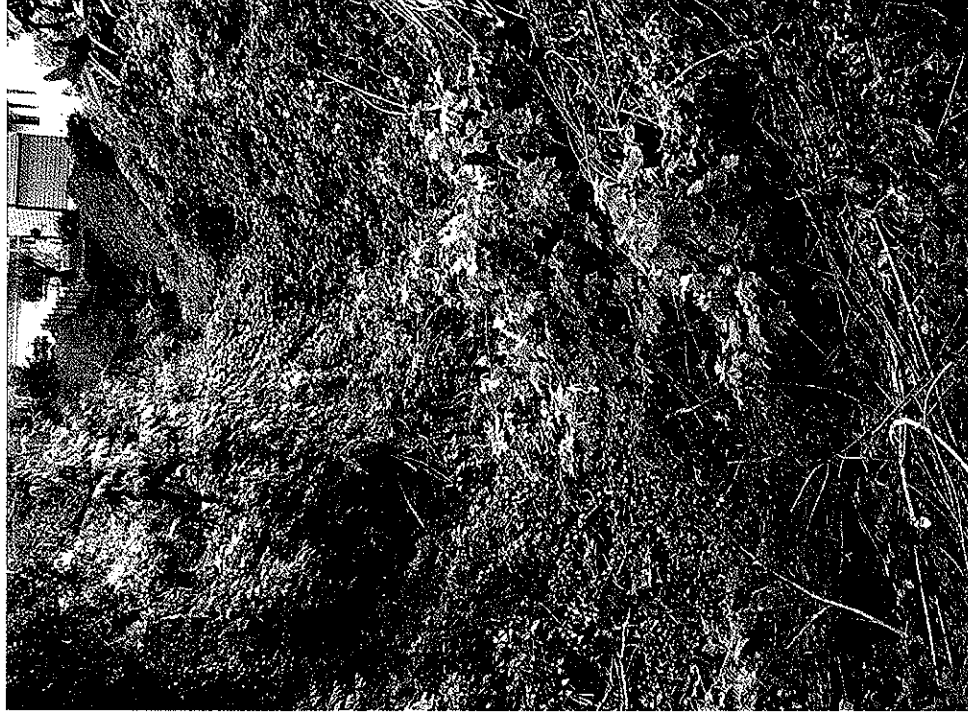
SB-8 Shellabarger Creek, north fork.

Shellabarger Creek

Pentec Environmental
12130-14



SB-9 Shellabarger Creek, modified channel,
north fork.



SB-10 Shellabarger Creek, south fork.

WILLOW CREEK



W-1 View downstream, twin culverts under BNRR tracks directing Edmonds Marsh drainage to Puget Sound (10/20/98).



W-2 Channelized lower portion of creek along Admiral Way (10/20/98).



W-3 View upstream, Edmonds Marsh on left (west) (10/20/98)..



W-4 Substrate of lower creek in intertidal zone (10/20/98).

Willow Creek

Pentec Environmental
12130-14



W-5 Riparian cover in braided zone.



W-6 Willow Creek, downstream view from fish hatchery (12/07/01).

Willow Creek

Pentec Environmental
12130-14



W-7 Willow Creek, moderate-gradient reach above Pine Street culvert (10/20/98).



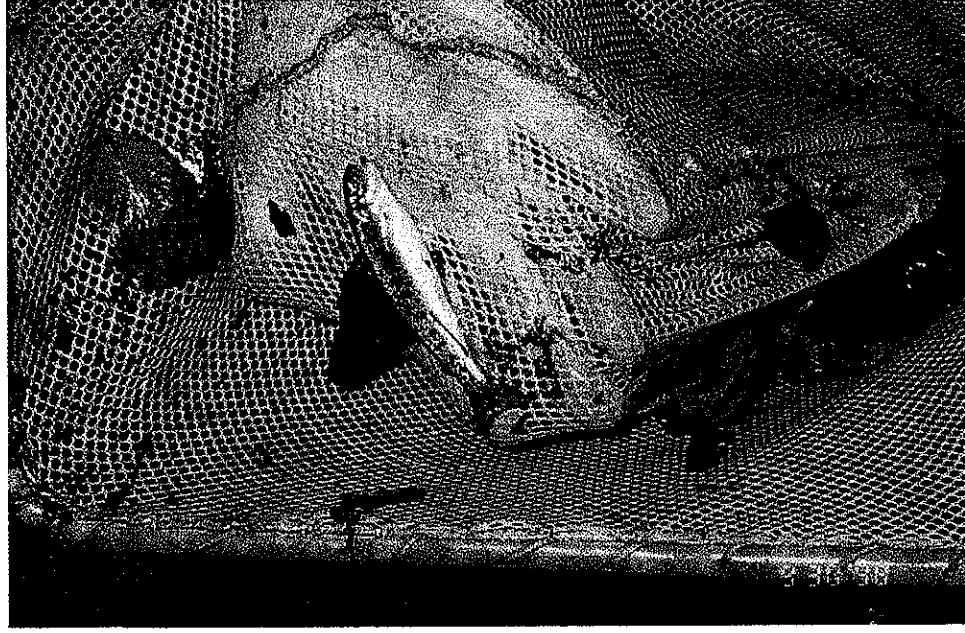
W-8 Willow Creek, impassible barrier above Pine Street (10/20/98).

Willow Creek

Pentec Environmental
12130-14



W-9 Willow Creek, downstream of Woodway
Park Road.



W-10 Willow Creek, native cutthroat trout
captured above Pine Street (10/01/98).