Swan Creek Channel Creation and Stream and Wetland Enhancement

Biological Evaluation

Draft Report

Prepared for:

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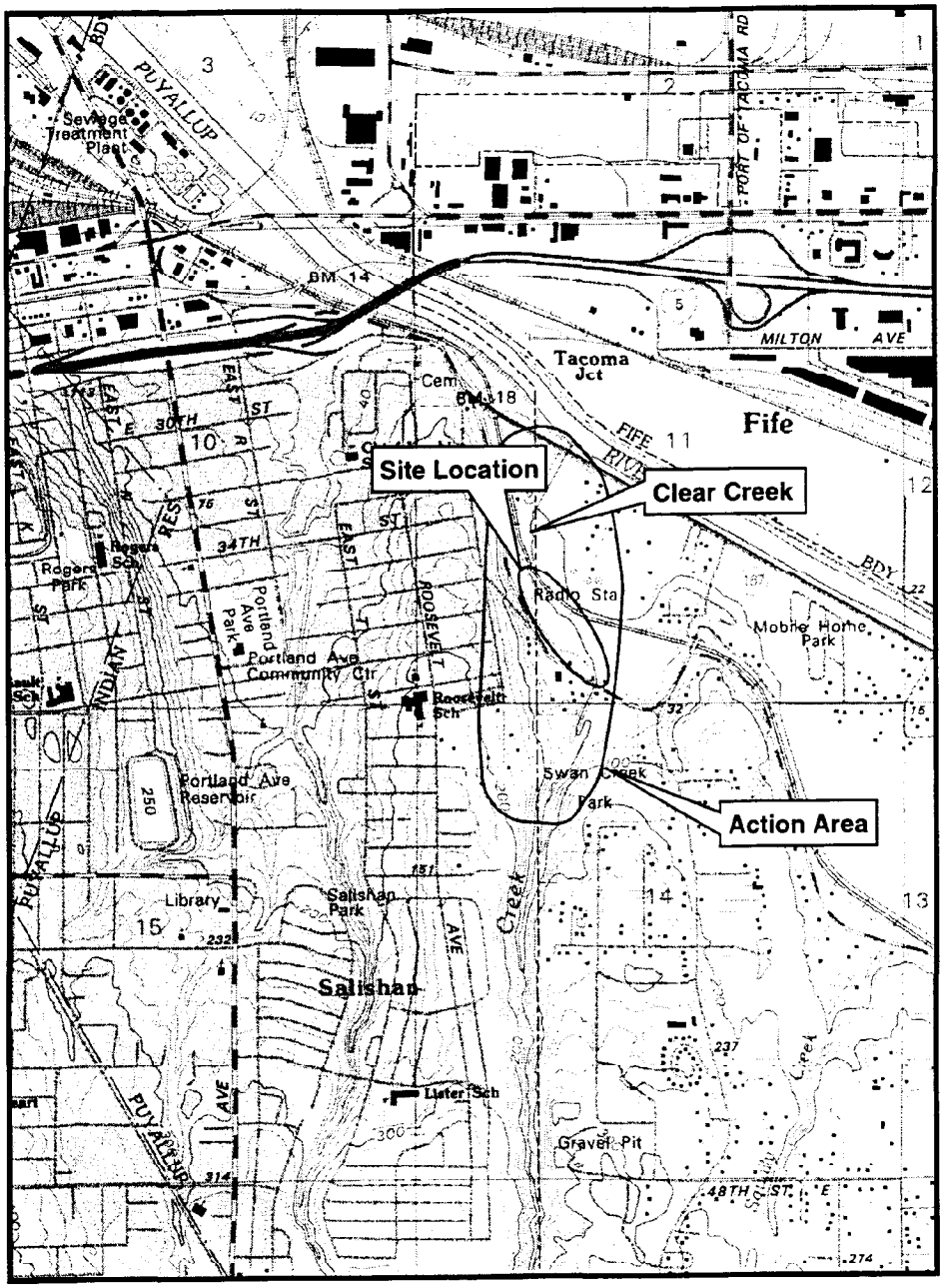
1.0 INTRODUCTION

The City of Tacoma (City) is proposing to restore and enhance a 12-acre site located in Section 11, Township 20N, Range 3E in Tacoma, Washington (Figure 1). This site contains a 3.0-acre wetland complex named the Haire Wetland and the former 2-acre Walter Wetland. Approximately 1,600 ft of Swan Creek flows through this site. Swan Creek is a tributary to Clear Creek, itself a tributary to the lower Puyallup River. The City is proposing to create a channel that connects Swan Creek to the Haire Wetland and to enhance a portion of Swan Creek and the Haire Wetland that is associated with Swan Creek (Figure 2). Because this project may impact species listed as threatened or endangered under the Endangered Species Act (ESA), steps must be taken, as described below, to investigate potential effects of the proposed project on these species and their habitat.

On May 24, 1999, the National Marine Fisheries Service (NMFS) formalized the listing of Puget Sound chinook salmon (*Oncorhynchus tshawytscha*) as threatened under the ESA. On October 28, 1999, the US Fish and Wildlife Service (USFWS) listed bull trout (*Salvelinus confluentus*) as threatened under the ESA. These listings require that NMFS and USFWS (referred to as the "services") be consulted pursuant to Section 7 of the ESA by federal agencies making any decisions that may affect these species. In this case, the US Army Corps of Engineers (Corps) will issue a Nationwide Permit for the restoration and enhancement action along Swan Creek. As part of the consultation, the Corps must prepare a biological evaluation (BE) of the potential impact of their action on listed species. Pentec Environmental, Inc. (Pentec), prepared this BE for the City's submittal to the Corps and the services to aid the services in decision-making regarding the proposed Swan Creek restoration and enhancement project. This BE generally follows the format and content specified by NMFS (1999).



Map prepared from
USGS 7.5 Minute Quadrangle
Tacoma South, Washington

Pentec ENVIRONMENTAL	Swan Creek Biological Evaluation Tacoma, Washington for the City of Tacoma	Figure 1 Site vicinity map.

10/25/99 fig_1.FH8

To determine what listed, proposed, or candidate species occur in the action and/or project area (defined in Section 2.1), Pentec contacted each of the services. Mr. Thom Hooper, NMFS (pers. comm., 1999), indicated that Puget Sound chinook salmon and coho salmon (*O. kisutch*) may be present in the project area and/or action area.

The USFWS also responded to a similar request with a list of endangered, threatened, proposed, and candidate species in the Swan Creek area (Jackson, G., USFWS, pers. comm., 1999, Appendix A). The letter from USFWS indicated that the anadromous form of the bull trout may occur in the project area, as well as the bald eagle (*Haliaeetus leucocephalus*).

This document therefore addresses potential effects of the proposed project on chinook and coho salmon, bull trout, bald eagle, and their habitat. The existing conditions in Swan Creek, on the former Walter property, and in the Haire Wetland, and the proposed restoration and enhancement work in these areas, have been described in detail in a previous document (Pentec 1999). Sections of that report are duplicated in Appendices B and C.

2.0 PROJECT DESCRIPTION

2.1 PROJECT LOCATION

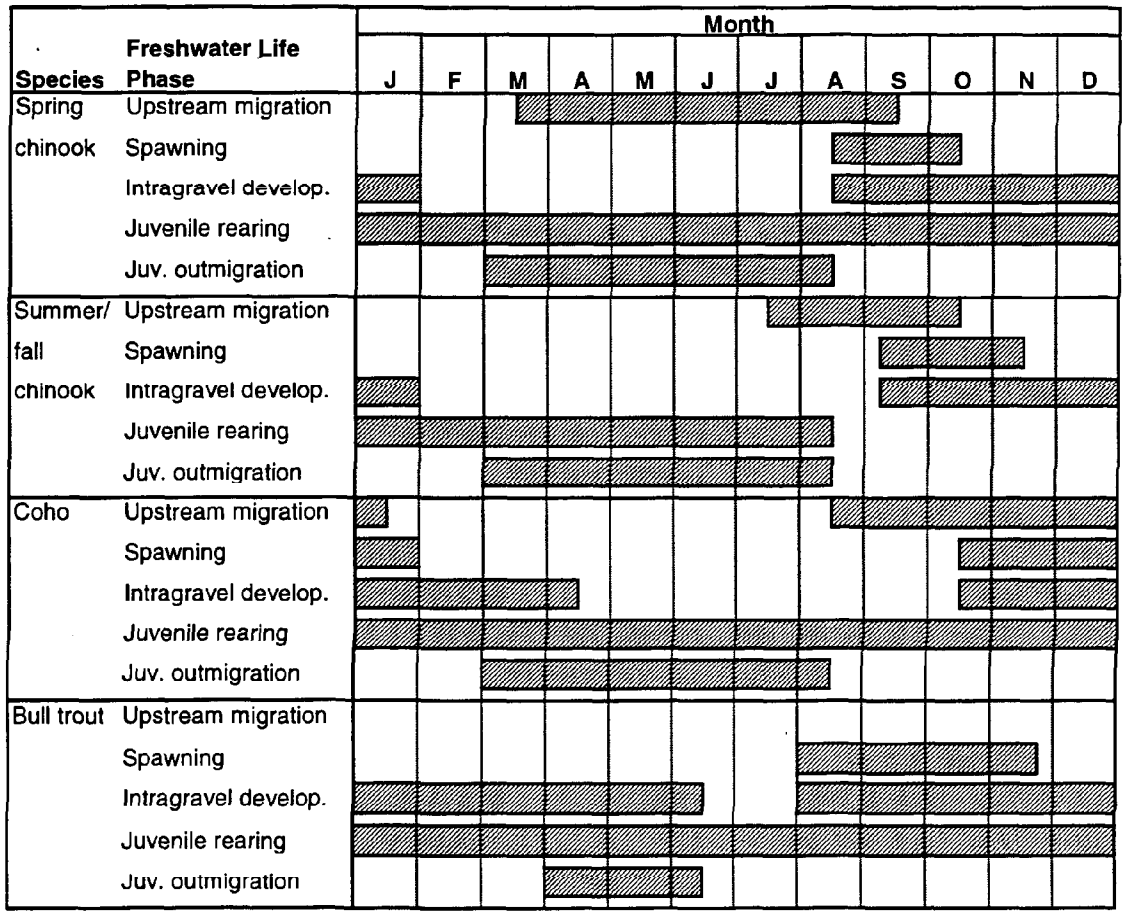
The project area's eastern and western boundaries are the base of the Northern Pacific Railroad bed and Pioneer Way, respectively, and the southern and northern boundaries are the culvert that passes under Pioneer Way and the land that is parallel to 34th Street, respectively (see Figure 1). The action area for this project is lower Swan Creek and lower Clear Creek to its confluence with the Puyallup River at river mile 3 (Figure 1).

2.2 CHANNEL CREATION, AND STREAM ENHANCEMENT AND RESTORATION PLAN

Coho salmon is the only salmonid species considered in this report that is documented to inhabit Swan Creek (WDFW 1998, WDFW and WWTIT 1994, Williams et al. 1975). The timing and life history phases of coho are shown in Figure 3. Coho rear in fresh water for at least 1 year before migrating to saltwater; therefore, adequate summer and winter habitat is needed to ensure the survival of this species. Recent (spring 1999) studies by the Port of Tacoma have found juvenile chinook salmon smolts in Clear Creek as far up as the mouth of Swan Creek (Grette, G., Pacific International Engineering, Inc., pers. comm., October 1999). These fish are presumably from Puyallup River stocks, not from local spawning, however, movement of some chinook juveniles into lower Swan Creek is a distinct possibility. Additionally, resident and sea-run cutthroat (*O. clarki*) and steelhead/rainbow trout (*O. mykiss*) may inhabit this portion of Swan Creek and would benefit from created, enhanced, and restored fish habitat.

The proposed project entails creating a 530-ft, meandering stream channel (Channel A) that will connect Swan Creek to the 3-acre Haire Wetland, thus providing access for juvenile salmonids to this wetland for rearing. Additionally, Channel A will provide salmonids with summer and winter rearing habitat and potentially spawning habitat (Figure 4). Two weirs will be installed to control water flow into and out of Channel A. One weir will be installed at the confluence of Swan Creek and Channel A, and one weir will be installed at the outlet of the channel into the Haire Wetland. The weir at Swan Creek will be adjustable to allow for any needed modifications in the amount of water that flows from Swan Creek into Channel A. The

Figure 3 Puyallup River salmonid life history stages.



Sources: PNRBC 1970, WDFW and WWTIT 1994, City of Tacoma 1998.

project design has taken into consideration the minimum flows that are needed in Swan Creek to avoid creating fish passage barriers. The Haire Wetland will then be connected to the lower reach of Swan Creek by a second channel (Channel B). Enhancement work is also planned for the lower reach of Swan Creek: Two log will structures will be installed to increase invertebrate production and provide potential spawning habitat for coho and cutthroat, and two flow-constrictor structures will be installed to flush out sediment in this section. A detailed project description, including hydrologic and biological criteria for the channel design, is provided in Appendix B.

2.3 RIPARIAN, WETLAND, AND UPLAND HABITAT PLANTING PLAN

The goal of the proposed planting plan is to enhance the structural complexity and diversity of existing plant communities. This goal will be achieved by removing and replacing invasive species with native plants typically and historically found in palustrine wetlands and adjacent forested uplands in the Pacific Northwest region. Enhancing and restoring native plant communities will improve the natural biological support functions of both wetland and upland plant communities. In addition, the existing and created wetland complex will improve the water quality protection and flood storage and attenuation functions compared to existing conditions. Furthermore, the native plant communities are expected to provide instream and overhead cover and a source of terrestrial insects to salmonids and other fishes that use Swan Creek. A detailed description of the planting enhancement plan is described in Appendix B.

2.4 SCHEDULE AND CONSTRUCTION METHODS

The channel construction and the enhancement work in Swan Creek and in the wetland and riparian zones will begin August 1, 2000, and will continue through November 1, 2000. This work is planned outside the fish window (which is March 15 through June 14), when few salmonids other than locally rearing residents and juvenile coho, cutthroat, and steelhead are expected to be present. However, adult coho may begin to enter the system in late October. To avoid impacting coho adult migration, work in Swan Creek will take place between August 1, 2000, and September 1, 2000.

A backhoe will be used to excavate Channels A and B, and the area of Swan Creek where enhancement work will take place. It is expected that during excavation for Channel A, substantial amounts of water inflow will be encountered, particularly from permeable zones of

wood chips; therefore, it is anticipated that dewatering will be necessary during channel excavation to control water inflow and possible caving of excavated sidewall soils, and to allow placement of 3 ft of clean fill soils as necessary. Excavation can be accomplished to depths of about 6 to 10 ft before groundwater is reached and dewatering becomes necessary. At this point, a series of dewatering wells will be installed along the inner perimeter of the excavation and used to draw down the immediate groundwater levels, so that additional excavation can be accomplished. It is anticipated that the pumped water will be returned to the Haire Wetland, possibly with some time spent in a temporary settlement basin (most likely, a portion of the channel excavation) so that fine sediments settle out. Turbidity measurement of the pumped water will be taken before this water is returned to the Haire Wetland. Water will not be returned to the Haire Wetland until the turbidity measurements are less than 5 NTUs above the water in the Haire Wetland. During excavation it may also be necessary to install temporary sump pumps to remove any remaining water from the excavated surface.

A total of 6,200 cubic yards of fill will be removed from the former Walter property and disposed of either on site or at a licensed facility. Suitable excavated soil may be utilized on site to create topographic features, such as small berm between Pioneer Way and the restored wetland area. Material might also be used to create a similar berm in places between the pedestrian walkway and project habitat areas as a method of encouraging people to use only developed pedestrian access facilities. There will be no excavation or filling in wetlands.

Invasive vegetation will be removed either by hand or using a backhoe.

Work at the site will be sequenced to avoid turbidity or suspended solids within Swan Creek or the Haire Wetland. During the installation of the weir at Swan Creek and during construction of the stream improvements in Swan Creek, a diversion will be established to temporarily divert streamflow from Swan Creek. The diversion will be accomplished using sandbags or other materials. The stream's temporary route will maintain flow away from the area of work and will return flow to its regular course downstream of the area of work. The exact route of diverted flow and location of its return to the bed of Swan Creek will be determined by the contractor in the field. The diverted flow will be east of the existing creek bed.

Erosion- and sediment-control methods are described and a layout is shown on Sheet 8 of 8. These erosion- and sediment-control methods, which will minimize erosion, loss of sediment,

and entry of sediment into Swan Creek or the Haire Wetland during construction of the proposed project, will include the following:

- Excavating and connecting the channels from the inside outward, such that the inlet and outlet connections to Swan Creek are made last, after excavation is completed, and after the turbid water that may be within the excavations has had time for suspended solids to settle
- Installing silt fences immediately downslope of all construction activities, including clearing, excavating, and soil placement
- Covering stockpiles of imported or excavated soil with secured plastic sheeting to minimize erosion and soil loss due to precipitation and wind
- Establishing stockpile and/or staging areas greater than 20 ft from the crest of the slope to the Haire Wetland, Swan Creek, or excavated sideslopes
- During dry conditions, spraying active areas of exposed soil with water to minimize dust
- Using stabilized construction entrances to the site for all ingress and egress by heavy equipment and trucks/trailers
- Placing sandbags or other flow-diversion structures to keep water from entering the excavated areas
- Constructing the temporary access road by laying down 12 inches of quarry spalls over a layer of filter fabric over the cleared subgrade, while minimizing removal of trees
- Following completion of construction, removing all temporary erosion and sediment controls and temporary access road(s) and restoring the site to its previous condition
- Protecting adjacent waters of Swan Creek and the Haire Wetland during construction of Channel B using temporary sandbag berms around inlet and outlet of channel
- Operating equipment from upland areas
- Mulching exposed soils

3.0 DESCRIPTION OF THE PROJECT AREA

3.1 GENERAL

The site is generally flat and is situated in a low area between a railroad bed (Northern Pacific Railroad) and the slope that forms the southern edge of the Puyallup River valley. The base of the railroad bed is coincident with the eastern property boundary. Pioneer Way defines the western boundary of the site along the base of the slope that forms the southern edge of the Puyallup River valley. The western portion of the site contains the 2.3-acre Haire Wetland complex and what was formerly the 2-acre Walter Wetland, which was filled in the early 1970s. The site's southern boundary is the outlet of the culvert that passes under Pioneer Way and the northern boundary is in line with 34th Street if extended in Tacoma.

Swan Creek flows north through the eastern portion of the site and then passes through a culvert under Northern Pacific Railroad, where it enters Clear Creek. Clear Creek flows into the Puyallup River at river mile 3.

Upland and wetland vegetation on the site is typical of disturbed and urbanized areas within the Puget Lowland region (Appendix C). Upland forests are composed entirely of deciduous tree species that are pioneers and the first to colonize disturbed or previously developed areas. Upland and wetland forest stands on the site are relatively simple, consisting primarily of mature deciduous trees of the same ages and height, and lacking structural diversity. Non-native and invasive plant species commonly found in the region are abundant in both upland and wetland vegetation communities on the site, especially around previously filled areas, existing structures, along Pioneer Way, near the railroad tracks, and on the banks of previously channelized sections of Swan Creek.

3.2 SUMMARY OF EXISTING FISH HABITAT CONDITIONS

Pentec conducted a fish habitat survey in June and July 1999. (A detailed description of the habitat survey is provided in Appendix C.) This survey revealed that the fish habitat conditions in Swan Creek between the outlet of the Pioneer Way culvert and the inlet of the Northern Pacific Railroad culvert lack suitable spawning habitat for fish living in this system.

Additionally, this portion of Swan Creek does not have suitable substrate to foster invertebrate communities.

Based on this information, the enhancement plan for Swan Creek will include the creation of a 530-ft, meandering spawning and rearing channel for coho and possibly cutthroat trout. This channel will connect Swan Creek with the Haire Wetland, and will provide coho and cutthroat trout rearing habitat for both summer and winter months. Off-channel winter and summer habitat has been shown to increase coho smolt production (Everest et al. 1985). The enhancement plan also will call for adding gravel and cobble substrate to Swan Creek to enhance the invertebrate populations, which will increase the food available to fish in the system. Additionally, a flow-constrictor structure will be placed in conjunction with the cobble and gravel substrate to increase flow, which will flush out fine sediment and slow the sedimentation process.

3.3 VEGETATION

Vegetation communities were distinguished by dominant plant species, habitat structure, topography, and apparent hydrologic regime. An area was identified as a wetland if it exhibited the following three characteristics: (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology. Wetland plant communities were classified according to the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). The location and geographic extent of each community was determined by visual estimation and the use of a base map carried during the field investigation. Identification of some plant communities as wetlands is tentative, and will be confirmed using the information gathered during the jurisdictional wetland delineation performed by the City of Tacoma.

Although these plant communities are represented as distinct units, community boundary lines are approximate and are not always abrupt or distinct in the field. This is due to interspersion of plant species between adjacent vegetation communities. In addition, the degree to which the vegetation communities are distinguished from each other varies across the site.

The Haire Wetland and riparian vegetation associated with Swan Creek cover most of the site. In total, eight plant communities were identified within the project area (see Figure 5). The

communities classified as wetland appear to meet the criteria for hydrophytic vegetation, hydric soils, and wetland hydrology. The general characteristics of these communities are summarized in this section, as are the wildlife habitat and known or likely species present on the site. A complete description of the vegetation in each community is provided in Appendix C.

The wetland on site contains a number of different wetland vegetation classes and habitat types, including forested, emergent, and unconsolidated bottom. Also, there are some other specific habitat features within the wetland complex, including snags, large woody debris, and apparently permanently inundated areas (sometimes called open water). These features are most abundant in Community B. The relatively large size, edge habitat, and continuity with mature forested uplands likely provide habitat for many mammals, birds, reptiles, and amphibians commonly found in western Washington.

Swan Creek, the Haire Wetland complex (including Communities B, E, F, and G), and adjacent forested uplands (including Communities A, C, and D) support a diverse array of habitat for fish and wildlife. However, many of these habitats provide relatively limited value due, in part, to relatively low structural and habitat diversity. Dense communities of invasive species, including Himalayan blackberry (*Rubus discolor*) and reed canarygrass (*Phalaris arundinacea*), contribute to the relatively low structural diversity and diminished habitat values.

Results of the reconnaissance investigations done on the site were used to develop enhancement and restoration plans within the different communities. Proposed plantings of shrubs and trees were selected for their compatibility with existing vegetation and based on existing site conditions. In addition, plant species also were selected based on their ability to contribute to habitat diversity and complexity.

4.0 LIST OF SPECIES

This BE addresses chinook salmon, bull trout, and the bald eagle, which have been listed as threatened with endangerment in the Puget Sound area. This BE also covers coho salmon, which is a candidate species.

5.0 DESCRIPTION OF THE SPECIES AND HABITAT

5.1 CHINOOK SALMON

Like all Pacific salmon, chinook reproduce in fresh water, but most of their growth occurs in marine waters. Chinook juveniles rear in the Puyallup River or its tributaries for periods of a few weeks to over a year before migrating downstream to the Puget Sound and out to the Pacific Ocean (Figure 3).

In watersheds with an unaltered estuary (and historically in the Puyallup estuary), chinook smolts spend a prolonged period (several days to several weeks) during their spring outmigration feeding in saltmarshes and distributary channels as they transition gradually into more marine waters (Simenstad et al. 1982). Chinook fry and subyearlings in saltmarsh and other shallow habitat predominantly prey on emergent insects and epibenthic crustaceans such as gammarid amphipods, mysids, and cumaceans. As chinook mature and move to neritic habitat, they feed on small nekton (decapod larvae, larval and juvenile fish, and euphausiids) and neustonic drift insects (Simenstad et al. 1982; see also detailed life history review by Healey 1991).

Two races, or runs, of chinook salmon, a spring/summer run and a fall run, are found in the Puyallup River system. Spring chinook historically spawned primarily in upper tributaries of the White River and perhaps the mainstem of the Puyallup and Carbon rivers (Williams et al. 1975). Rearing occurs in the spawning areas and in lower mainstem reaches; most outmigrate as subyearlsings (Muckleshoot Indian Tribe et al. 1996) and may rear for a time in Commencement Bay. Historic spring chinook runs (pre-1950) averaged nearly 3,000 fish, but recent runs have been much reduced, and supported primarily by artificial production (WDFW and WWTIT 1994). Fall chinook spawn throughout larger streams in the Puyallup system, including the

mainstem of the Puyallup, the lower White and Carbon rivers, and Kapowsin, South Prairie, and Voight creeks. Historic average run size of fall chinook has been 3,000 to 4,000 fish (Williams et al. 1975). In contrast, data from Table 1 indicate that the total Puyallup system natural chinook escapement (both runs) has averaged 2,401 fish over the 1991-1996 period.

As a result of the physical alterations of the Puyallup estuary, chinook (and other salmon) juveniles reaching the river mouth are forced to migrate along shorelines that provide suboptimal conditions for feeding, shelter, and physiological transition to living in areas of high salinity. Abundance of epibenthic prey may be high at middle and lower tidal elevations, but productive, low-gradient mudflats are lacking at higher tidal elevations (e.g., Blaylock and Houghton 1981); this may limit the opportunities for feeding on benthic prey during periods of high tide, and hasten the shift of feeding mode from epibenthic to pelagic prey. Moreover, epibenthic prey may be contaminated by close association with the sediments; contaminants taken up from the food and water appear to decrease the ability of juvenile salmon to survive future challenges (e.g., Varanasi et al. 1993, Arkoosh et al. 1991 Stein et al. 1995).

Table 1 Puyallup River escapement estimates for naturally reproducing (native, non-native, and mixed origin) summer/fall chinook, coho, and steelhead trout.

Year	Summer/Fall Chinook	Coho	Steelhead Trout
1983	1,184	4,100	2,241
1984	1,258	3,600	2,237
1985	1,147	3,200	2,471
1986	740	1,700	3,767
1987	925	6,200	2,329
1988	1,332	4,200	3,396
1989	2,442	1,300	3,354
1990	3,515	6,600	1,950
1991	1,702	5,500	1,898
1992	3,034	1,900	2,313
1993	1,999	2,600	1,596
1994	2,526	9,400	1,631
1995	2,701	4,700	2,146
1996	2,444	6,600	1,368
1983-1990 Average	1,568	3,863	2,718
1991-1996 Average	2,401	5,117	1,825

Source: Baranski, C., WDFW, pers. comm., 1998.

5.2 COHO SALMON

Coho salmon typically spend one or two full years rearing in streams and rivers before beginning their migration to sea (Figure 3). Within a few days after emergence, coho fry congregate in quiet backwaters, side channels, and small creeks, especially utilizing shady areas with overhanging branches (Sandercock 1991). Older fry occupy areas along open shorelines and progressively move into areas of higher velocity in midstream and on the stream margins. Off-channel habitat is especially important during the winter months when higher flows exist. Coho prefer habitat areas with very low flow. Coho fry primarily feed on drifting organic material consisting of stream and terrestrial insects while in fresh water (Sandercock 1991). When yearlings, coho become predators, eating fry of their own and other species as well as insects. Because of their larger size when entering saltwater, coho are generally considered less dependent on estuarine rearing than chinook or chum salmon (Simenstad et al. 1982). Coho tend to move through estuaries more rapidly, using deeper waters along shorelines. Feeding is primarily on planktonic or small nektonic organisms including decapod larvae, larval and juvenile fish, and euphausiids (Miller et al. 1976, Simenstad et al. 1982). Coho also eat drift insects and epibenthic gammarid amphipods, especially in turbid estuaries (see detailed life history review by Sandercock 1991).

Historically, coho salmon spawned in all accessible streams and tributaries of the Puyallup River system, including the mainstem of the Puyallup, Carbon, and White rivers (Kapowsin, Canyonfalls, Fennel, and Fiske creeks on the Puyallup; and Boise, Slippery, and Huckleberry creeks, plus West Fork, Greenwater, and Clearwater rivers on the White; and South Prairie and Voight creeks on the Carbon River). An estimated 112 linear miles of stream were used by spawning coho salmon. Rearing occurred in all streams used by spawning adults and throughout the mainstem Puyallup, Carbon, and White rivers. The lower mainstem Puyallup River and the estuarine waters of Commencement Bay were most important.

Natural coho escapement to the Puyallup system averaged 50,000 fish per year from 1966 to 1971, with a range of 42,000 to 70,000 fish (Williams et al. 1975). More recently, coho escapement has averaged 3,863, with a range of 1,300 to 6,600 for the years 1983 through 1990 (Table 1). From 1991 through 1996, the coho escapement average was 5,117, with a range of 1,900 to 9,400.

5.3 BULL TROUT

The status and occurrence of anadromous populations of bull trout in Puget Sound are subject to some scientific debate; separation of anadromous bull trout from the closely related anadromous Dolly Varden char (*S. malma*) is very difficult and can only be accomplished using electrophoretic techniques (Leary and Allendorf 1997). Until further resolution is possible, the Washington Department of Fish and Wildlife (WDFW) has made a decision to manage all Puget Sound stocks as if they were a single bull trout/Dolly Varden complex (Washington Department of Wildlife [WDW, now WDFW] 1993).

Bull trout spawn in the fall in streams containing clean gravel and cobble substrate and gentle slopes, with cold, unpolluted water. Bull trout require long incubation periods (4 to 5 months) compared with other salmon and trout. Fry hatch in late winter or early spring and remain in the gravel for up to 3 weeks before emerging. A few weeks after emerging, some bull trout migrate to saltwater, while the remainder stay in the streams where they hatched (USFWS 1998). Small bull trout eat terrestrial and aquatic insects. Large bull trout are primarily fish predators, eating whitefish, sculpins, and other trout (USFWS 1998). Bull trout are more sensitive to changes in temperature, poor water quality, and low flow conditions in fresh water than many other salmon because of their life history requirements (USFWS 1998).

The bull trout population in the Puyallup River has been separated into three stocks: the Puyallup River, White River, and Carbon River stocks. Although there are no genetic data available to determine if these stocks are distinct, WDFW considers them distinct stocks due to the probable geographic isolation of their spawning populations (WDFW 1997). Timing of spawning and specific spawning locations are unknown for all three stocks. Information to determine the status of the three stocks is insufficient, but all three stocks are native and maintained by wild reproduction (WDFW 1997). Historical accounts indicate anadromous bull trout entered the three drainages in "vast numbers" in the mid-1800s (Suckley and Cooper 1860). Today, total abundance for the Puyallup River stock is believed to be less than 5,000 individuals or 500 adults (Chan, J., WDFW, pers. comm., 1999). There are insufficient data to determine population trends for the White and Carbon River stocks (WDFW 1997).

5.4 BALD EAGLE

The bald eagle is found along the shores of saltwater, and freshwater lakes and rivers. In Washington, breeding territories are located in predominantly coniferous, uneven-aged stands with old-growth components. Territory size and configuration are influenced by a variety of habitat characteristics, including availability and location of perch trees for foraging, quality of foraging habitat, and distance of nests from waters supporting adequate food supplies. Habitat models for nesting bald eagles in Maine show that the eagles are selecting areas with (1) suitable forest structure, (2) low human disturbance, and (3) highly diverse or accessible prey (Rodrick and Milner 1991).

Bald eagles typically build nests in mature old-growth trees, which are generally used in successive years. In Washington, courtship and nest-building activities generally begin in January and February. Egg laying begins in March or early April, with eaglets hatching in mid-April or early May. Eaglets usually fledge in mid-July and often remain in the vicinity of the nest for another month (Rodrick and Milner 1991). No bald eagle nests or territories are located in the project or action areas (WDFW 1999).

Eagles often depend on dead or weakened prey, and their diet may vary locally and seasonally. Various carrion, including spawned salmon taken from gravel bars along wide, braided river stretches, are important food items during fall and winter. Waterfowl often are taken as well. Anadromous and warm-water fishes, small mammals, seabirds, and carrion are consumed during the breeding season (Rodrick and Milner 1991).

6.0 INVENTORIES AND SURVEYS

The use of Swan Creek by chinook or coho salmon, or bull trout is not well documented. Although WDFW (1999) reports that coho salmon inhabit Swan Creek, no detailed studies of juvenile or adult use of Swan Creek by coho salmon is available. No data regarding the use of Swan Creek by chinook salmon or bull trout is available. The Port of Tacoma has been conducting ongoing studies on salmonid use of the lower reaches of Clear Creek and the Puyallup River. These studies document that chinook salmon use Clear Creek upstream to the mouth of Swan Creek (Grette, G., Pacific International Engineering, Inc., pers. comm., October 1999) but there is no documented use of Swan Creek by chinook, although juvenile chinook salmon could utilize Swan Creek. Pentec (1999) assessed the salmonid habitat conditions in Swan Creek during June and July of 1999 (Appendix C).

No bald eagle nests or territories are reported within a 1.5-mile radius of the proposed project site (WDFW 1999a, b, c).

7.0 ANALYSIS OF EFFECTS

7.1 GENERAL

Short-term and localized construction effects on water quality and waterborne noise will be timed to occur during periods of the year when minimal numbers of anadromous salmonids are expected to be present (Figure 3).

Juvenile salmonids have been shown to avoid areas of unacceptably high turbidities (e.g., Servizi (1988); they also may seek out areas of moderate turbidity (10 to 80 NTU) presumably as cover against predation (Cyrus and Blaber 1987a,b). Feeding efficiency of juveniles is also impaired by turbidities in excess of 70 NTU, well below sublethal stress levels (Bisson and Bilby 1982). Reduced preference by adult salmon homing to spawning areas has been demonstrated where turbidities exceed 30 NTU (20 mg/L suspended sediments). However, chinook exposed to 650 mg/L of suspended volcanic ash were still able to find their natal water (Whitman et al. 1982). Based on these data, it is unlikely that the locally elevated turbidities generated by the proposed action would directly affect juvenile or adult salmonids that may be present.

The following net long-term improvements to salmonid habitat will result from the combined stream channel creation and stream and wetland enhancement project: This project will create approximately 2,249 ft² of instream rearing habitat for all species of juvenile salmonids, and spawning habitat for adult coho and cutthroat trout. Additionally, this project will provide access to 3 acres of existing wetlands for salmonid rearing habitat.

All of these changes are considered to be positive in terms of quality of habitat for salmonids in the Swan Creek drainage.

Although no bald eagle nests or territories occur near the proposed project, bald eagles may fly over the site. Because this project will potentially increase spawning habitat for salmonids, thereby increasing the number of salmonids in the project area, there will be an increase in forage food for bald eagles. Therefore, this project will benefit bald eagles.

7.2 INTERDEPENDENT, INTERRELATED, AND CUMULATIVE EFFECTS

A number of active programs have had or will have cumulative positive effects on the status of salmon in the Puyallup River drainage. The Recovery Plan for White River Spring Chinook Salmon (Muckleshoot Indian Tribe et al. 1996) identifies a series of objectives and actions designed to enhance the recovery of White River spring chinook, the only remaining spring run of chinook in the Puyallup system. These actions are targeted at improved freshwater spawning and rearing conditions with the goal of reducing run dependence on artificial production.

Increasingly strict enforcement of Clean Water Act Section 404, and the State of Washington Hydraulic Project Approval rules (WAC 220-110) and guidelines requiring "no net loss" of wetlands and habitat for fish and shellfish resources, have reversed the trend of continued losses of marine littoral habitat that had persisted from the time of earliest Euro-American settlement through the 1970s. The first major project for which a substantial mitigation area was provided was the Port of Tacoma's completion in 1986 of the 9.6-acre Gog-Li-Hi-Ti tidal wetland approximately 2 km up the Puyallup River. This project was constructed as compensation for filling a similar-sized site containing isolated wetlands. Subsequent monitoring (Shreffler et al. 1992) has shown that this saltmarsh/mudflat complex provides a productive foraging area for juvenile salmonids including chinook.

About the same time (1988), a settlement was reached between the Simpson Tacoma Kraft Company and the EPA that resulted in the capping of an area of contaminated sediments at the end of the peninsula between the Puyallup River and the St. Paul Waterway to create about 7.5 acres of restored littoral habitat. This site has been monitored continually (e.g., Parametrix 1997) and has been shown to have a rich and diverse infauna and epibenthos, as well as seasonal use by juvenile salmon migrating out from the Puyallup River. The Port of Tacoma has also completed mitigation projects at Rhone-Poulenc and the Fairliner Marina site in the Blair Waterway.

In addition, the Port has expanded an existing freshwater wetland at Clear Creek up the Puyallup River and provided for access by juvenile salmon. Monitoring to date has indicated that this project will more than meet their goals for provision of habitat for juvenile salmonids, among other species.

7.3 POTENTIAL EFFECTS ON PROPOSED CRITICAL HABITAT

Based on the preceding discussion, the proposed stream channel creation and stream and wetland enhancement project will have no adverse effect on chinook critical habitat because chinook salmon are not known to inhabit Swan Creek, although if juvenile spring chinook migrate into Swan Creek for rearing, this project will have a positive affect by providing additional rearing habitat. The proposed project will have a net positive effect on other salmonid habitat including coho salmon rearing habitat within the Swan Creek drainage. Additionally, if bull trout inhabit the Swan Creek drainage, this proposed project will not adversely affect their critical habitat.

8.0 MANAGEMENT ACTIONS RELATED TO THE SPECIES

The preceding impact assessment indicates that the proposed project will result in a net positive effect on salmonid habitats in the Swan Creek drainage. Because the proposed action will result in net positive impacts on salmonid habitat, no mitigation is warranted or planned.

9.0 CONCLUSION

The existing habitat in Swan Creek and the Haire Wetland in the project area contains rearing habitat for coho salmon, but chinook salmon and bull trout probably do not use this area. Improvement of the habitat conditions in the lower Puyallup drainages has been occurring over the past few years. This proposed project will have a net positive effect on juvenile salmonid habitat and is one more step in the trend of improving habitat in the lower Puyallup drainages.

This BE leads to the following conclusion regarding the potential effects of the Swan Creek streamchannel creation and stream and wetland enhancement project on chinook salmon, coho salmon, and bull trout: **The project may affect but is not likely to adversely affect chinook or coho salmon, or bull trout, or their critical habitat.** Chinook salmon and bull trout, because they most likely do not use the Swan Creek drainage, will be less affected by the short-term disturbances and the positive aspects of the project.

This BE concludes further that the proposed action will have **no effect on bald eagles** that may occur in the project vicinity.

10.0 REFERENCES

Arkoosh, M.R., E. Casillas, E. Clemons, B. McCain, and U. Varanasi. 1991. Suppression of immunological memory in juvenile chinook salmon (Oncorhynchus tshawytscha) from an urban estuary. Fish and Shellfish Immunology 1:261-277.

Bisson, P.A., and R.E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. North American Journal of Fisheries Management 4:371-374.

Blaylock, W.M., and J.P. Houghton. 1981. Commencement Bay studies technical report, volume IV, Invertebrates. Prepared for the US Army Corps of Engineers, Seattle, District, Seattle, Washington, by Dames & Moore, Seattle.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service, Office of Biological Services, Publication FWS/OBS-79/31, Washington, DC.

Cyrus, D.P., and S.J.M. Blaber. 1987a. The influence of turbidity on juvenile marine fishes in estuaries. Part 1: Field studies at Lake St. Lucia on the southeastern coast of Africa. Journal of Experimental Marine Biology and Ecology 109:53-70.

Cyrus, D.P., and S.J.M. Blaber. 1987b. The influence of turbidity on juvenile marine fishes in estuaries. Part 2: Laboratory studies, comparisons with field data and conclusions. Journal of Experimental Marine Biology and Ecology 109:71-91.

Everest, F.H., G.H. Reeves, J.R. Sedell, J. Wolfe, D. Hohler, and D.A. Heller. 1985. Abundance, behavior, and habitat utilization by coho salmon and steelhead trout in Fish Creek, Oregon, as influenced by habitat enhancement. Bonneville Power Administration, Portland, Oregon.

Healey, M.C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-394 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Vancouver, BC, Canada.

Leary, R.F., and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Miller, B.S., B.B. McCain, R.C. Wingert, S.F. Borton, and K.V. Pierce. 1976. Ecological and disease studies of fishes near Metro operated sewage treatment plants on Puget Sound and the Duwamish River. University of Washington, School of Fisheries, Fisheries Research Institute, FRI-7608, Seattle.

Muckleshoot Indian Tribe, Puyallup Tribe of Indians, and Washington Department of Fish and Wildlife. 1996. Recovery plan for White River spring chinook salmon. Washington Department of Fish and Wildlife, Olympia.

NMFS (National Marine Fisheries Service). 1999. A guide to biological assessments. Attachment 1: final ESA section 7 consultation handbook, March 1998; Attachment 2: making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. Prepared by NMFS, Environmental and Technical Services Division, Habitat Conservation Branch, Lacey, Washington.

Parametrix, Inc. 1997. St. Paul Waterway area remedial action and habitat restoration project, 1997 monitoring report. Prepared for Simpson Tacoma Kraft Co., Tacoma, Washington, and Champion International, Stamford, Connecticut.

Pentec (Pentec Environmental; Inc.). 1999. Design of Swan Creek off-channel pond and stream and wetland enhancement. Review draft. Prepared for the City of Tacoma, Washington.

Rodrick, E., and R. Milner, technical editors. 1991. Management recommendations for Washington's priority habitats and species. Washington State Department of Wildlife, Olympia.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). Pages 395-446 *in* C. Groot and L. Margolis, editors. Pacific life histories. UBC Press, Vancouver, BC, Canada.

Servizi, J.A. 1988. Sublethal effects of dredged sediments on juvenile salmon. Pages 57-63 *in* C.A. Simenstad, editor. Effects of dredging on anadromous Pacific Coast fishes. University of Washington, Seattle.

Shreffler, D.K., C.A. Simenstad, and R.M. Thom. 1992. Foraging by juvenile salmon in a restored estuarine wetland. Estuaries 15(2):204-213.

Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function. Pages 343-364 in V.S. Kennedy, editor. Estuarine comparisons. Academic Press, New York.

Stein, J.E., T. Hom, T.K. Collier, D.W. Brown, and U. Varanasi. 1995. Contaminant exposure and biochemical effects in outmigrant juvenile chinook salmon from urban and nonurban estuaries of Puget Sound, Washington. Environmental Toxicology and Chemistry 14:1019-1029.

Suckley, G., and J.G. Cooper. 1860. Reports explorations and surveys, to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Vol. XII. Book II. Thomas H. Ford, Printer, Washington, DC.

USFWS (US Fish and Wildlife Service). 1998. Bull trout facts. US Fish and Wildlife Service, Portland, Oregon.

Varanasi, U., E. Casillas, M.R. Arkoosh, T. Hom, D.A. Misitano, D.W. Brown, S-L. Chan, T.K. Collier, B.B. McCain, and J.E. Stein. 1993. Contaminant exposure and associated biological effects in juvenile chinook salmon (Oncorhynchus tshawytscha) from urban and nonurban estuaries of Puget Sound. NOAA Technical Memorandum NMFS NWFSC 8.

WDFW (Washington Department of Fish and Wildlife). 1997. Salmonid stock inventory: appendix, bull trout and Dolly Varden. Washington Department of Fish and Wildlife, Olympia.

WDFW (Washington Department of Fish and Wildlife). 1998. Washington's native chars [online report]. Olympia, WA: WDFW. URL: <http://www.wa.gov/wdfw/outreach/fishing/char.htm>.

WDFW (Washington Department of Fish and Wildlife). 1999. Priority habitats and species database, habitat and species map for Poverty Bay quad, 4712233; Tacoma South quad, 4712224; and Tacoma North quad, 4712234. WDFW, Olympia.

WDFW and WWTIT (Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes). 1994. 1992 Washington State salmon and steelhead stock inventory. Appendix One: Puget Sound stocks north Puget Sound volume. WDFW and WWTIT, Olympia.

WDW (Washington State Department of Wildlife). 1993. Bull trout/Dolly Varden: management and recovery plan. WDW, Fisheries Management Division, Olympia.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization, volume 1, Puget Sound region. Washington State Department of Fisheries, Olympia.

Whitman, R.P., T.P. Quinn, and E.L. Brannon. 1982. Influence of suspended volcanic ash on homing behavior of adult chinook salmon. Transactions of the American Fisheries Society 111:63-69.

Appendix A— Response Letter from USFWS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Pacific Coast Ecoregion
Western Washington Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 753-9518

OCT 2 2

Dear Species List Requester:

You have requested a list of listed and proposed threatened and endangered species, candidate species, and species of concern (Attachment A) that may be present within the area of your proposed project. This response fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act of 1973, as amended (Act). We have also enclosed a copy of the requirements for Federal agency compliance under the Act (Attachment B).

Should the Federal agency determine that a listed species is likely to be affected (adversely or beneficially) by the project, you should request section 7 consultation through this office. If the Federal agency determines that the proposed action is "not likely to adversely affect" a listed species, you should request Service concurrence with that determination through the informal consultation process. Even if there is a "no effect" situation, we would appreciate receiving a copy for our information.

Both listed and proposed species may occur in the vicinity of the project. Therefore, pursuant to the regulations implementing the Act, impacts to both listed and proposed species must be considered by the Federal agency in a Biological Assessment (BA) (Attachment B for more information on preparing BAs). Formal conference with the Service is required by the Act if the federal agency determines that the proposed action is likely to jeopardize the continued existence of a proposed species, or result in the destruction or adverse modification of proposed critical habitat. The results of the BA will determine if conferencing is required. If the species is ultimately listed, your agency may be required to reinitiate consultation.

Species of concern are those species whose conservation standing is of concern to the Service, but for which further status information is still needed. Conservation measures for species of concern are voluntary, but recommended. Protection provided to these species now may preclude possible listing in the future.

There may be other Federally listed species that may occur in the vicinity of your project which are under the jurisdiction of the National Marine Fisheries Service (NMFS). Please contact NMFS at (360) 753-9530 to request a species list.

In addition, please be advised that Federal and state regulations may require permits in areas where wetlands are identified. You should contact the Seattle District of the U.S. Army Corps of Engineers

for Federal permit requirements and the Washington State Department of Ecology for State permit requirements.

Your interest in endangered species is appreciated. If you have additional questions regarding your responsibilities under the Act, please contact Bobbi Barrera at (360) 753-6048, or John Grettenberger of this office, at the letterhead phone/address.

Sincerely,

for

Gerry A. Jackson
Supervisor

BB
Enclosure(s)

c: COE
WDFW Region 4

ATTACHMENT A **October 13, 1999**

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR WITHIN THE VICINITY OF THE PROPOSED SWAN CREEK RESTORATION PROJECT IN PIERCE COUNTY, WASHINGTON

(T20N R03E S10,11)

FWS REF: 1-3-99-SP-1472

LISTED

Bald eagle (*Haliaeetus leucocephalus*) - There is one bald eagle nesting territory located in the vicinity of the project at T20N R03E S13. Nesting activities occur from January 1 through August 15.

Wintering bald eagles may occur in the vicinity of the project. Wintering activities occur from October 31 through March 31.

Major concerns that should be addressed in your biological assessment of the project impacts to listed species are:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project construction (i.e., habitat loss, increased noise levels, increased human activity) which may result in disturbance to listed species and/or their avoidance of the project area.

PROPOSED

Bull trout (*Salvelinus confluentus*) - Coastal/Puget Sound population occur in the vicinity of the project.

CANDIDATE

None.

SPECIES OF CONCERN

The following species of concern may occur in the vicinity of the project:

Pacific lamprey (*Lampetra tridentata*)
River lamprey (*Lampetra ayresi*)

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2. Consultation with FWS when a federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and

3. Conference with FWS when a federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species which is/are likely to be affected by a construction project. The process is initiated by a federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with the Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Endangered Species Division, 510 Desmond Drive SE, Suite 102, Lacey, WA 98503-1273.

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* "Construction project" means any major federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes federal action such as permits, grants, licenses, or other forms of federal authorization or approval which may result

in construction.

Appendix B— Enhancement and Restoration Plan

APPENDIX B
ENHANCEMENT AND RESTORATION PLAN

The City of Tacoma (City) is proposing to restore and enhance a 12-acre site located in Section 11, Township 20N, Range 3E in Tacoma, Washington. This site contains a 3-acre wetland complex named the Haire Wetland and the former 2-acre Walter Wetland. Approximately 1,600 ft of Swan Creek flows through this site. The City is proposing to create a 530-ft, meandering stream channel that will connect Swan Creek to the associated Haire Wetland and enhance a portion of Swan Creek and the Haire Wetland. The proposed action is described herein.

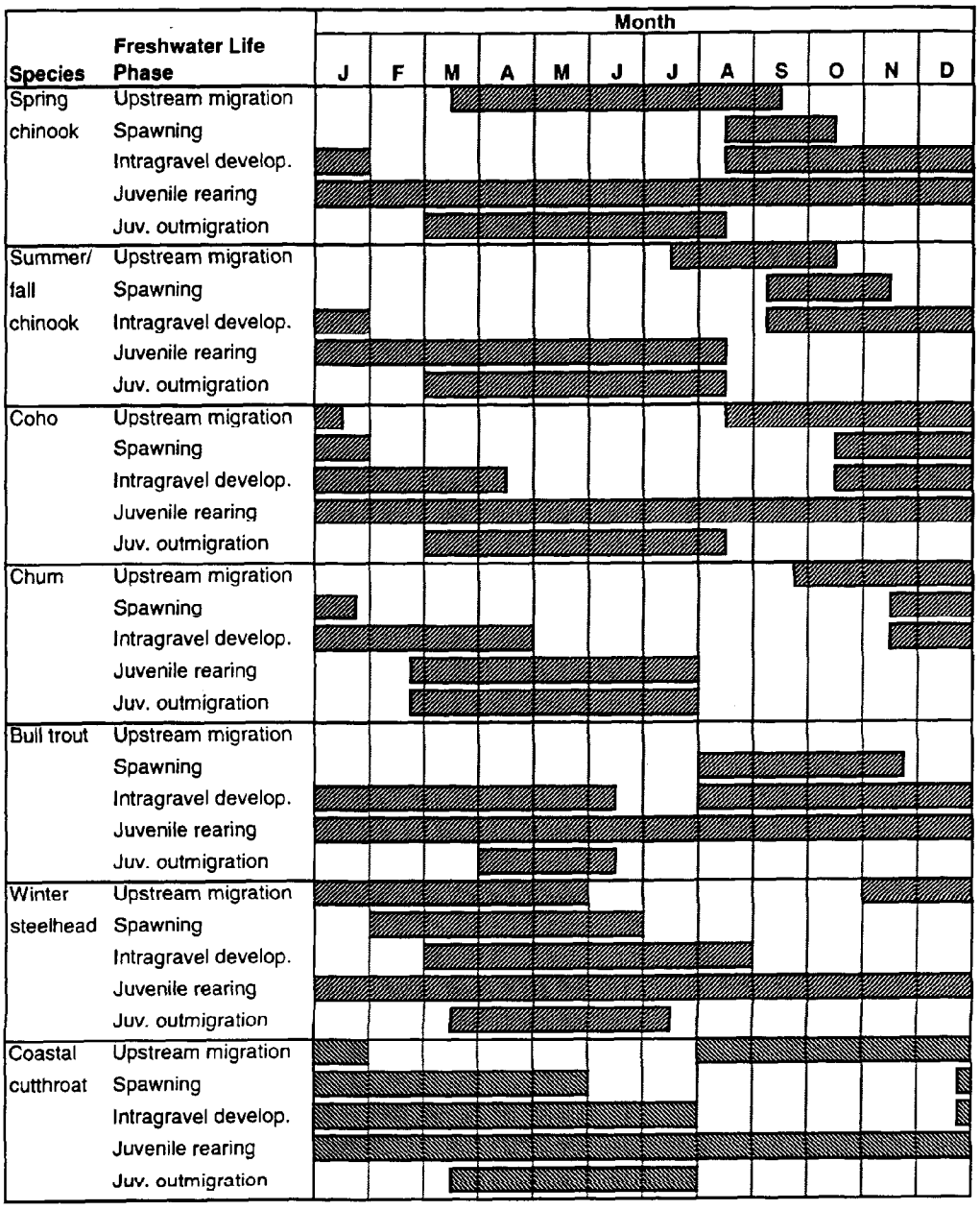
FISH HABITAT

Coho salmon (*Oncorhynchus kisutch*), chum salmon (*O. keta*), and steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*) are the anadromous salmonid species found in Swan Creek (WDFW 1999, WDFW and WWTIT 1994, Williams et al. 1975). The timing and life history phases of each of these species are shown in Figure B-1. Chum salmon spend the least amount of time in fresh water where as coho salmon and steelhead and searun cutthroat trout rear in fresh water for at least 1 year before migrating to saltwater; therefore, adequate summer and winter habitat is needed to ensure the survival of these salmonids. Additionally, resident cutthroat and rainbow trout may inhabit this portion of Swan creek and would benefit from enhanced, restored, and created fish habitat.

The objectives of the fish enhancement plan are as follows:

- Increase the coho and cutthroat trout spawning habitat in the Swan Creek drainage.
- Provide off-channel rearing habitat for coho salmon and cutthroat and rainbow/steelhead trout, and amphibian and invertebrate species.
- Provide increased and enhanced wetland habitat for salmonids inhabiting the lower Puyallup River system and estuary.
- Increase invertebrate production and salmonid spawning habitat in the lower reach of Swan Creek.
- Increase public awareness of the importance of diverse salmonid habitat in stream systems by providing stewardship and educational opportunities for city and county residents.

Figure B-1 Puyallup River salmonid life history stages.



Sources: PNRBC 1970, WDFW and WWTIT 1994, City of Tacoma 1998.

To achieve these objectives, a meandering stream channel (Channel A) will be designed and created to provide salmonids with summer and winter rearing habitat and, potentially, spawning habitat for coho salmon and cutthroat trout in the Swan Creek drainage. Channel A will connect the Swan Creek to the Haire Wetland, to allow fish access into this habitat. The Haire Wetland will then be connected to the lower reach of Swan Creek by a second channel (Channel B). Enhancement work is also planned for the lower reach of Swan Creek: Two log sill structures will be installed to increase invertebrate production and provide potential spawning habitat for coho and cutthroat, and two flow-constrictor structures will be installed to flush out sediment in this section.

HYDROLOGICAL AND BIOLOGICAL CRITERIA

The proposed stream channel will be designed to provide diverse habitat for summer- and winter-rearing juvenile coho salmon and cutthroat trout. Large woody debris structures and boulder structures will be placed in the stream to provide cover. The design of Channels A and B will satisfy hydrological criteria to tolerate 100-year flood events and biological criteria necessary to facilitate fish passage and encourage the use of the channels for salmonid rearing and spawning. Based on the species of fish present in Swan Creek and the existing habitat in the Swan Creek drainage, the habitat created will most favor coho salmon and cutthroat trout. For this reason, channel design will be directed toward optimizing habitat features desirable to these species.

Included in the design elements for the fluvial fish habitat are (1) channel gradient, (2) cross-sectional area, (3) substrate (size, amount, sorting), (4) residual pool depth, (5) habitat structures, (6) velocity (estimated maximum and minimum), (7) weir heights, and (8) riparian coverage. Included in the controlling variables for these designs are (1) discharge (maximum and minimum estimated flows), (2) sediment load, and (3) topography and space. The goals of the fish habitat design include (1) maintaining an appropriate temperature range, (2) providing diverse and complex habitat, (3) maintaining sufficient flow in Swan Creek, and (3) accounting for interspecies interactions. Table B-1 details criteria necessary to achieve a functional channel for spawning and rearing.

Table B-1 Criteria to achieve functionality of stream channel for salmonid spawning (adults) or rearing (juveniles).

Channel Criteria	Juvenile Coho	Adult Coho	Juvenile Trout	Adult Trout
Minimum depth[1] (inches)	~ 9	~ 7.1 migration[2] ~ 7.1 spawning[2]	~ 12	~ 4.7 (migration)[2] ~ 2.4 (spawning)[2]
Maximum velocity[2] (fps)	< 1	8.04 (migration) 1 – 3 (spawning)	< 0.7	4.02 (migration) 0.25 - 2.4 (spawning)
Substrate preference[2]	Gravel to boulders (0.25 > 12 inch), size and age dependent	0.5 - 4 inch (spawning)	Gravel to boulders (0.25 > 12 inch), size and age dependent	0.24 - 4 inch (spawning)
Temperature (°C)[2]	1.7 (lower lethal) 12-14 (preferred) 26-29 (upper lethal)	7.2 - 15.6 migration 4.4 - 9.4 spawning 4.4 - 13.3 incubation	0.6 (lower lethal) 12-16 (preferred) 22.8 (upper lethal)	6.1 - 17.2 (spawning)
Dissolved oxygen (mg/liter)	> 7.75 (optimum) ≤ 6 (stressful) ≤ 3.5 (lethal)	> 5 migration and spawning[2]	> 7.75 (optimum) ≤ 6 (stressful) ≤ 3.5 (lethal)	> 5 migration and spawning[2]
Max. mean gradient (in reach length of 525 ft)	No data	7%[3]	No data	12%[3]
Cover	Standing crop linked to amount and diversity	Maximum redd distance from cover ≤ 10 ft	Standing crop linked to amount and diversity	Maximum distance of redd from cover ≤ 10 ft
Ratio of scour pool depth (SPD) to jump height (H)	SPD ≥ 1.25 x H	SPD ≥ 1.25 x H	SPD ≥ 1.25 x H	SPD ≥ 1.25 x H
Barrier height (jump at 90° angle)	0.5 ft	7.22 ft (maximum)[2] ≤ 2 ft (optimum)[4]	0.5 ft	2 ft[2] ≤ 1 ft (optimum)[4]

1 In general, channel depth to support migration and spawning must be adequate to cover the maximum body width of the migrating salmonid and is therefore highly size-dependent.

2 Bjornn and Reiser (1991).

3 SSHEAR Program 1997, as found in Thurston County barrier inventory (WDFW 1997).

4 Protocols for assessing fish passage at culverts (Burton, unpublished).

CHANNEL DESIGN AND EXCAVATION

Channel A will be excavated entirely on the former Walter Wetland (see Sheet 3). This new channel will be excavated from Swan Creek at approximately 146 ft downstream of the Pioneer Way culvert to the inlet of the Haire Wetland, which is approximately 300 ft north and 250 ft west of the mouth of the new channel. This new channel will be designed to have a water depth of 6 to 12 inches. A weir will be installed in Swan Creek downstream from the inlet to

Channel A to ensure there is adequate flow through Swan Creek during the summer months. The water elevation at the mouth of the channel is 13.3 ft and a weir will control water flow into the channel. The water elevation at the inlet to the Haire Wetland will be 12.5 ft and controlled by a weir. Channel B will be excavated between the Haire Wetland and Swan Creek at approximately 980 ft downstream of the Pioneer Way culvert. The elevation of this channel at the outlet of the Haire Wetland is 12.5 ft and the elevation of the inlet to Swan Creek is 10.0 ft.

Sideslopes in Channel A and B will be shaped at 2H:1V (see Sheet 4 [A]) The total length of Channel A is projected to be 530 ft, with a watershed length of 453 ft, thereby achieving a sinuosity of 1.17. The total length of Channel B is 43 ft, with a watershed length of 35 ft, thereby achieving a sinuosity of 1.22. Instream structures and habitat will be placed as described in the subsequent section.

Table B-2 Channel specification summary.

	Channel A Swan Creek to Haire Wetland	Channel B Haire Wetland to Lower Swan Creek
Beginning elevation (ft)	13.3	12.5
Ending elevation (ft)	12.5	10.0
Total elevation change (ft)	0.8	2.5
Total length of channel	530 ft	43 ft
Lineal distance of channel	453 ft	35 ft
Channel slope	0.21 percent	5.8 percent
Channel sinuosity	1.17	1.22

IN-CHANNEL HABITAT DEVELOPMENT

Habitat features installed within Channel A will include eight to nine deflector log structures, six to eight logjam structures, six to eight rootwads, and 20 to 30 large boulders (see Sheet 6 [1 and 3] and Sheet 7 [5]). A 1-ft-thick gravel and cobble substrate will be used in this channel and a brush mattress with an optional rock toe will be used to stabilize the banks along the channel (Figure B-2). The deflector log and logjam structures and boulders are proposed along the stream at 25- to 35-ft intervals in order to provide lateral pools and cover, thereby diversifying the instream habitat (see Sheet 3).

Appropriately sorted spawning gravel will be placed in the streambed to create interstitial habitat for invertebrates and potential spawning and rearing habitat for cutthroat trout and coho salmon (see Sheet 4 [A]). It must be noted that the elevations provided in Table B-2 refer to the final elevation of the channel bottom, after the channel has been filled with gravel. Gravels in the 0.25- to 3-inch size range will be used to line the bottom of all channel segments to an average depth of 1 ft (see Sheet 4 [A]). This depth is necessary to ensure that the gravels are usable by cutthroat and coho for spawning.

An evaluation of sediment transport capacity of the channel demonstrates that the normal range of expected flows (1 to 10 cubic feet per second [cfs]) will flush out silt and sand from the pools while leaving the spawning gravel unmodified. Ordinary high flows of 5 cfs would be sufficient to flush out 2-mm sediment and smaller (sands, silt, and clay) from the spawning gravel. An extreme flow of 50 cfs within Channel A would transport sediments up to 12 mm in diameter; thus, gravels placed within the channel would not be dislodged over the range of flows anticipated through the channel.

Habitat features installed within Channel B will include three rootwads, three weirs, and cobble and gravel substrate. Rootwads will be placed in the bank at approximately 25-ft intervals on opposite sides of the bank (see Sheet 3and 6 [1]). The weirs will be made of log sections that will be 9 ft long and secured into the excavated channel by footer rocks underlying the downstream end of each log, and by backfilling over the outer 2 ft of each log (see Sheet 6 [2]). Log placement will create a series of step pools designed to maintain a minimum water depth of 6 to 12 inches at low-flow conditions (see Sheet 4 [2]). The logs will be placed every 10.5 ft for a total of 3 weirs. This arrangement will limit the maximum drop to approximately 4.8 inches, ensuring that none of the log structures limits fish passage for salmonid fingerlings and fry. A single layer of cobble (3 to 6 inches) will also line each step pool to provide for rearing habitat and to minimize scour. Given the necessity for cobble lining in these areas and the desire to maintain a pool depth that exceeds the mean channel depth, the initial lining with gravel in each step pool (i.e., immediately downstream of each log) will not exceed a thickness of 3 inches; the cobble will thus overlie the gravel in these areas.

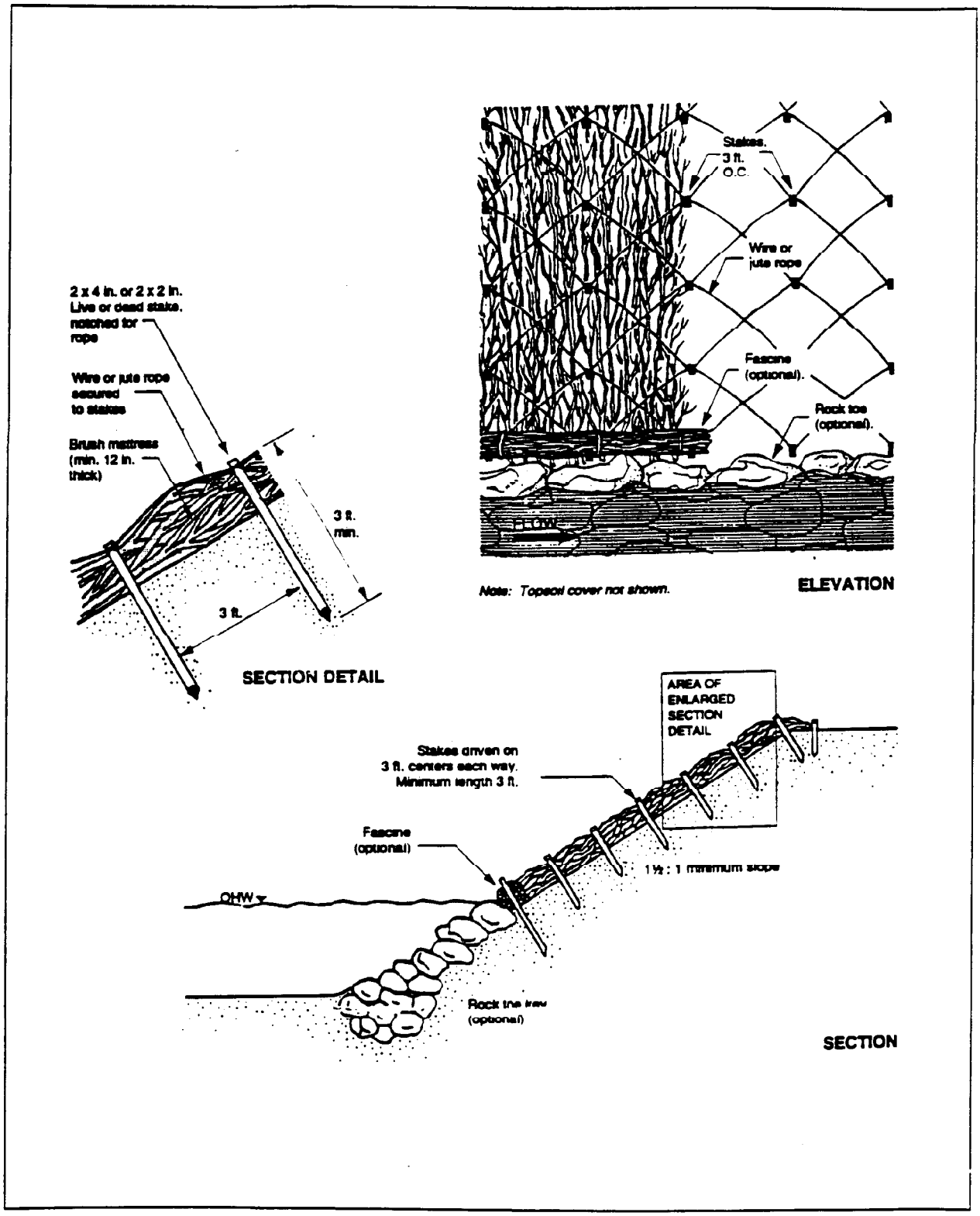


Figure B-2 Installation of a brush mattress shown with an optional fascine and rock toe. (Adapted from Gray and Leiser 1982.) (From Johnson and Stypula 1993.)

Two flow-constrictor log structures will be installed in Swan Creek between 1,050 ft and 1,150 ft (distance measured from the Pioneer Way culvert) (see Sheet 6 [4]). These structures are designed to increase flow velocity in this reach and therefore flush out sediment. Additionally, rock of diameter 0.25 to 4 inches will be placed in the streambed to create interstitial habitat for invertebrates and potential spawning and rearing habitat for cutthroat trout and coho salmon (see Sheet 7 [6]).

RIPARIAN, WETLAND, AND UPLAND HABITAT PLANTING PLAN

The goal of the proposed planting plan is to enhance the structural complexity and diversity of existing plant communities. This goal will be achieved by removing and replacing invasive species with native plants typically and historically found in palustrine wetlands and adjacent forested uplands in the Pacific Northwest region. Enhancing and restoring native plant communities will improve the natural biological support functions of both wetland and upland plant communities. In addition, the existing and created wetland complex will improve the water quality protection and flood storage and attenuation functions compared to existing conditions. Furthermore, the native plant communities are expected to provide instream and overhead cover and a source of terrestrial insects to salmonids and other fishes that use Swan Creek.

Plant Material

All material to be used will be plants native to the Northwest. Much of the native plant material will be obtained from plant nurseries. If season, weather, and soil conditions allow, bare-root plants may be used. Bare-root stock is recommended only for riparian restoration areas, including plant Communities A, C, and D (see Sheet 5 and Appendix C of this report). Otherwise, containerized plants will be used, except where willow, black twinberry (*Lonicera involucrata*), black cottonwood, and red-osier dogwood live stakes are specified. To the maximum extent practicable, black cottonwood, Sitka willow, black twinberry, and red-osier dogwood cuttings will be obtained on site from locations where mature plants of these species are abundant. Collections of cuttings from on-site sources will be done by a wetland ecologist or mitigation specialist to ensure that donor plants are not decimated. Plant substitutions may be allowed based on the recommendation of a project biologist or mitigation specialist, or by permitting agency. Substitutions also may be based in part on plant availability.

All species selected for planting are well-adapted to anticipated moisture and climate conditions, and are expected to thrive following successful establishment. Typical planting details and plant schedules (see Sheet 5) have been developed for each plant community identified in the field investigation that will be restored or enhanced. Many of the different sizes and types of plants specified in these areas have been selected because they were observed on the site or appear to be well-suited to conditions and project goals and objectives.

Planting Density

Spacing of trees and shrubs varies depending on planting location, vegetation zone, plant type (tree or shrub), and growth habit. It is assumed that the highest planting densities will be used in the southern portion of Community A, which is expected to be cleared of most existing vegetation to construct the proposed off-channel and wetland habitat. Lowest densities are specified for dense, second-growth, deciduous, upland forest communities (Communities C and D). See the typical planting details and plant schedules (see Sheet 5) for specific densities and species of plants to be used in each community.

Site Preparation

Soils within each community will be modified where necessary to maximize native plant establishment success. Decisions on whether soil amendments will be required will be determined at the time of planting by the consulting biologist or mitigation specialist. If during excavation, it becomes apparent that soil organic matter content in any of the enhancement or restoration areas is unfavorable to native plant establishment, soils in the immediate vicinity of all bare-root, container-stock, and rooted-cutting plantings will be amended with topsoil and mulch, as specified by the consulting biologist or mitigation specialist to promote successful establishment and growth. It is assumed that soil in the immediate vicinity of live-stake plantings will not need amending based on preliminary reconnaissance investigations for communities in which live stakes have been specified (see plant schedules).

Clearing, grading, and any soil amendments of the off-channel and wetland creation areas in Community A shall not occur when the ground is frozen or excessively wet. Following installation of bare root or containerized plants, a 3- to 4-inch layer of medium-fine bark mulch, compost, or equivalent material will be applied within a 2- to 4-ft radius of each shrub and tree,

Proposed Native Plant Community Enhancements

Below are the descriptions of the proposed enhancement within each community to be enhanced. The general limits of the enhancement and restoration within each community are shown on Sheet 5. Limited enhancement is proposed within Community E, as described below. No enhancement is proposed in Communities B and F. As indicated in the sections below, detailed plans for each community are shown in the typical planting details, typical sections, and plant schedules (see Sheet 5).

Community A

Prior to introducing native plants, all invasive species will be removed, including cherry laurel, Scot's broom, Himalayan blackberry, one-seeded hawthorn, and English ivy. A bulldozer or other excavator will be used to remove most of these species. To the maximum extent practicable, mature black cottonwoods and existing snags will be saved. English ivy will be removed (or a section of the stems removed to kill the plant) from all of the infested black cottonwoods that can be saved. Those snags and trees that cannot be saved will be used as habitat features in Community B or other communities on the site.

Stream Channel—An approximately 530-ft-long channel connecting Swan Creek to Haire Wetland will be constructed. This channel is expected to divert a portion of high flows from Swan Creek into this high-flow refuge habitat during the fall, winter, and spring.

Zone 4 is located upslope of Stream Channel A in adjacent uplands. Shrubs, arborescent shrubs, and trees will be planted in this zone, including Pacific ninebark, Pacific willow, Western crabapple (*Malus fusca*), Oregon ash (*Fraxinus latifolia*), black cottonwood, Sitka spruce (*Picea sitchensis*) and western red cedar (*Thuja plicata*). Cottonwood and conifers will be planted in upslope areas in Zones 4 and 5 to provide shading and bank stability (see planting detail for Communities A, C, and D and typical planting section for Community A-Constructed Wetland and Stream Channels). Together these plantings will create a more structurally diverse assemblage of native plants that provide breeding, feeding, and resting opportunities to many species of wildlife typically found in the western Washington. All of the species specified in these planting details are typically found in lowland wetland and upland plant communities in

western Washington. Spacing and densities of plants specified in the planting schedules for Community A are typical of those observed in plant communities within the Puget Sound region.

Constructed Stream Channel Zones (C1 and C2)—As shown on Sheet 5, inlet and outlet channels will be constructed to the Haire Wetland. Two planting zones will be established in the constructed channel area (Zone C1 and Zone C2). Zone C1 will extend from the OHWM upslope to near the top of bank. Zone C2 will extend from near the top of bank outward as shown in the planting detail and typical section for Zones C1 and C2. A combination of shrubs and trees will be used to create a mosaic of shrub and forest communities in these zones. Shrubs and trees often associated with streams and wetlands that are widely recognized for their rapid growth and bank stabilization characteristics have been selected for Zone C1, including red-osier dogwood, black twinberry, Pacific ninebark, Hooker willow (*Salix hookerina*), and Pacific willow. These species will provide bank stability and overhead cover relatively rapidly. Shrubs and trees selected for Zone C2 were selected in part for their rapid growth characteristics, as well as their tolerance of summer drought and growth forms. Snowberry, red elderberry (*Sambucus racemosa*), and vine maple (*Acer circinatum*) will form three tiers of shrub vegetation beneath the mixed deciduous and coniferous forest canopy formed by red alder, Oregon ash, Sitka spruce, Douglas fir, and western hemlock (*Tsuga heterophylla*). Berries and seeds of these species will provide food for a variety of wildlife and the vegetation will provide cover.

South of Channel A—An approximately 0.5-acre upland area south of Channel A (Zone 6) will be converted from primarily driveways and invasive species to upland forest. It is assumed that this area will be totally cleared and may be used to stockpile construction materials and equipment and as a staging area for constructing Channel A. Prior to using this area for these purposes, all invasive vegetation will be removed. Mature black cottonwoods will be saved wherever possible in this area.

Because all of the area south of Channel A will be cleared of vegetation, it will have to be more densely planted to prevent regrowth and spread of invasive species. The forest stand structure has been built around retention of existing black cottonwood trees. A mixture of deciduous and evergreen trees will be used to establish a multiple layered forest canopy. Madrone (*Arbutus menziesii*) and scattered Douglas fir and red alder will be used in the more open areas now occupied by buildings, meadow vegetation, and driveways. Shade-tolerant shrubs, including vine maple and hazelnut (*Corylus cornuta*) will be planted beneath existing

cottonwoods. A mixture of salal (*Gaultheria shallon*), tall Oregon grape (*Mahonia nervosa*), Indian plum, and oceanspray (*Holodiscus discolor*) will be planted between madrone, red alder, and evergreen trees as shown in the typical planting detail for this area. As shown in the plant schedule for Zone 6, a variety of ages (sizes) of trees will be used to create a more diverse stand structure and habitat.

Public Access Zone (Zone PA)—This community will border the public access trail, the mixed deciduous and coniferous forest in Zone 6, and Swan Creek. The assemblage of plants selected for this community provides different food and cover opportunities to wildlife than other community types, is aesthetically pleasing, and will deter people from trampling the banks of Swan Creek. Several species of trees and shrubs produce fruit eaten by wildlife commonly found in the Puget Sound region. Armed species, including Nootka rose (*Rosa nutkana*), Douglas hawthorn (*Crataegus douglasii*), and western crabapple, form dense thickets that will deter access to the west bank of Swan Creek. As with other communities, a mixture of different sizes of trees and shrubs will be used to create greater habitat and structural diversity (see Plant Material Schedule Community A – Zone PA). These species also will enhance existing overhead cover, provide better shade, and more breeding, feeding, and rearing opportunities of fish and wildlife than now exist along this reach of the creek.

Community B

No enhancement is proposed in this area, which contains dense shrub and deciduous forest communities around its perimeter. This area is a good source of willow, red-osier dogwood, black twinberry, and cottonwood cuttings that will be used for enhancing vegetation in Communities E and G as well as Zone C1 of the Constructed Stream Channel.

Although no plantings will be done in this community, large logs or stumps with rootwads attached will be placed in eight widely separated locations, 80 to 100 ft apart. Logs should be a minimum of 18 inches in diameter and 10 to 20 ft long. Logs will be installed by either mechanized equipment through either Communities C or D, or lowered in by helicopter. The logs and stumps will enhance habitat quality by providing resting areas and foraging habitat for frogs, reptiles, birds, and small mammals. As these features decompose, they also may provide breeding habitat for various species of wildlife, including woodpeckers, mice and voles, salamanders, and garter snakes.

Communities C and D

Reforestation will occur in Zones 4 and 5 of Communities C and D. Following removal of dense thickets of Himalayan blackberry, coniferous trees, including Douglas fir, Western hemlock, grand fir, western red cedar, and Sitka spruce, will be planted within the existing deciduous forest. Zone 4 is the area adjacent to the wetland and extends upslope to approximately the 20-ft contour (see Sheet 5). This zone is expected to be somewhat more mesic (wetter) habitat than Zone 5, which is located upslope. Sitka spruce and western red cedar, which are shade-tolerant and will tolerate moister soil conditions, will be placed in Zone 4. Douglas fir, western hemlock, and grand fir (*Abies grandis*) will be planted in Zone 5. Douglas fir, which is shade-intolerant, will be planted only in areas where the deciduous forest canopy is more open. Western hemlock and grand fir, which are shade-tolerant will be planted in areas beneath the denser deciduous forest canopy. Conifers will be planted in both zones in small groups and as scattered individuals. To simulate the multiple-tiered and age structures of naturally regenerated forests, different ages and sizes of conifers will be planted as specified in the plant schedules for Zones 4 and 5 (see Plant Materials Schedule – Communities A, C, and D for Zone 4 and Zone 5). This will contribute to greater habitat diversity in forest stand structure by creating small stands of conifers of mixed ages and heights as well individual conifers amidst stands of deciduous trees. In addition, the shade that the conifer stands will provide will help control the spread of invasive species, particularly Himalayan blackberry and Scot's broom, which are generally shade-intolerant.

Community E

A limited amount of enhancement will occur in Community E. Cuttings of shrubs collected on site will be planted on both banks of Swan Creek near to where it exits the property. Prior to planting these areas, similar to that shown in the typical detail for Constructed Stream Channel Zone C1, the reed canarygrass will be removed by hand. Where reed canarygrass has been removed, groups of live stakes of Sitka willow, red-osier dogwood, and black cottonwood will be planted to create a dense scrub-shrub and forested wetland community that will shade out the reed canarygrass. Sources of cuttings will include plants from Communities B and F.

Community F

No enhancement is proposed in this area, which contains dense scrub-shrub and deciduous forest vegetation. This area is a good source of willow, red-osier dogwood, black twinberry, and cottonwood cuttings.

Community G

Sitka willow, black cottonwood, red-osier dogwoods, and Oregon ash will be installed in this community. Plants will be in the form of both cuttings and ball-and-burlap seedlings. Above- and below-ground portions of reed canarygrass will be removed entirely within 4-ft-diameter circles evenly distributed across the community. Removal will be achieved by hand-shoveling. The intent of this planting method is to grow trees and shrubs that will eventually shade out the reed canarygrass.

SUMMARY

This project will provide approximately 2,249 ft^2 of instream rearing habitat for all species of juvenile salmonids, and spawning habitat for adult coho and cutthroat trout. A detailed list of materials required for construction of the two new channels is shown in Table B-3.

The combined enhancement and restoration activities will improve over 5.8 acres of fish and wildlife habitat, including the following:

- 4.3 acres of riparian forest will be restored or enhanced.
- Provide access to 3 acres of existing wetlands for salmonid rearing habitat.

The project includes removal and control of over 1.8 acres of invasive species in five different areas that now provide limited habitat value. In addition, about 0.5 acre of habitat will be created where very little or no habitat currently exists. Proposed restoration activities will remove about 0.5 acre of existing driveways, buildings, and invasive or ornamental plants in previously filled areas of the site.

Table B-3 Summary of construction materials.

Item Description	Approximate Quantity	Units
Earth work	6,200	Yd^3
Streambed gravel (0.25- to 3-inch-diameter stone)	65	Yd^3
Cobbles (3- to 6-inch-diameter stone)	10	Yd^3
Boulders (12- to 18-inch-diameter stone)	60	Each
Logs for log weirs (9-ft length x 16-18-inch diameter)	6	Each
Logs for triangular structures (10-ft length x 12- to 18-inch diameter)	56	Each
Rootwads 6-ft length x 12- to 18-inch diameter	11	Each
Jute matting	11,460	Ft^2
Hydroseed	0.50	Acres
Live stakes	100	Each

REFERENCES

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138.

WDFW (Washington Department of Fish and Wildlife). 1997. Thurston County barrier culvert inventory. WDFW, Olympia.

WDFW (Washington Department of Fish and Wildlife). 1999. Priority habitats and species database, habitat and species map for Poverty Bay quad, 4712233; Tacoma South quad, 4712224; and Tacoma North quad, 4712234. WDFW, Olympia.

WDFW and WWTIT (Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes). 1994. 1992 Washington State salmon and steelhead stock inventory. Appendix One: Puget Sound stocks north Puget Sound volume. WDFW and WWTIT, Olympia.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization, volume 1, Puget Sound region. Washington State Department of Fisheries, Olympia.

Appendix C— Existing Habitat Conditions in the Project Area

APPENDIX C
EXISTING HABITAT CONDITIONS IN THE PROJECT AREA

FISH HABITAT

Fish habitat surveys were conducted to provide baseline environmental data that would form the basis for identifying specific design objectives for the proposed restoration project. The intent of the study was to characterize both positive and negative aspects of the existing habitat conditions on the site. Beneficial habitat conditions would be protected and preserved through the construction process while negative conditions would be specifically targeted by the design effort. Fish habitat was evaluated in Swan Creek from the outlet of the Pioneer Way culvert to the inlet of the Northern Pacific Railroad culvert (Figure C-1). This section of Swan Creek was divided into four reaches based on habitat type (Figure C-1). Fish habitat was rated based on stream channel types and the conditions of both spawning and rearing habitat.

Methods

The current fish habitat conditions were determined using a habitat unit survey method similar to that described by Hankin and Reeves (1988), and the location of any barriers that could prevent movement of adult or juvenile salmonids were identified during the survey. The following habitat elements were examined: embeddedness (percentage fine sediment composition) of spawning gravel, percentage pool area, pool depth and cover class, dominant and subdominant substrate, and large woody debris (LWD).

In each survey reach, pools were tallied by depth category, pool tailouts were examined for the presence of spawning gravel, and the amount of spawning-gravel embeddedness was visually estimated by a habitat biologist. Pool depth categories were 0 to 7 inches, 7 to 14 inches, 14 to 28 inches, and 28 to 45 inches. Spawning gravel was defined as a patch of gravel containing particles ranging from 1 to 3.5 inches in diameter that covered a minimum area of 0.3 ft^2. Embeddedness estimate categories were less than 30 percent and greater than 30 percent.

An inventory of LWD was performed to provide information for an assessment of LWD functions relative to the formation of fish habitat. In each survey reach, all pieces of LWD observed within the bankfull influence zone were counted. Pieces of LWD were subdivided into

three size groups (4.5 to 14 inches, 14 to 28 inches, and greater than 28 inches) based on the estimated diameter at the large end of each piece. Each LWD structure (single piece or logjam) was identified, and the number of LWD pieces in each structure was counted.

Habitat Quality Ratings

Channel Types

Stream channel type influences the amount and quality of fish habitat in a stream. Stream channel types defined by Montgomery and Buffington (1993) based on physical properties and channel dynamics include the following: pool-riffle, forced pool-riffle, plane-bed, step-pool, braided, and regime. Substrate type is also a factor in habitat quality, because it influences invertebrate productivity.

A pool-riffle channel has an undulating bed featuring a sequence of sediment bars, pools, and riffles. Pool-riffle and forced pool-riffle channels tend to have a pool:riffle ratio of 1:1; this ratio results in sufficient pools to provide spawning and rearing habitat for fish and sufficient riffles to provide fertile habitat for invertebrate populations. The quality of the rearing habitat, however, depends on channel width and depth. A wider channel tends to have deeper pools, which are more beneficial to fish. Gravel substrates common in these two channel types are conducive to invertebrate productivity.

Plane-bed channels have a higher percentage of riffles than of pools; therefore, the amount of fish habitat is lower than in the pool-riffle and forced pool-riffle channels. On the other hand, step-pool channels have a higher percentage of pools than of riffles. Step-pool channels provide good fish rearing habitat but lack the substrate and riffle area needed for adequate invertebrate productivity.

Braided and regime channel types generally do not have a high percentage of spawning and rearing habitat. Braided channels have variable substrate; therefore, invertebrate productivity is also variable. Sandy substrates common to regime channels inhibit invertebrate productivity. A regime channel is a low-gradient channel characterized by sediment deposition.

Spawning Habitat

Ratings of spawning habitat quality were based on the embeddedness of the spawning gravel (Table C-1). Embeddedness is a subjective and is determined visually. When silt is present in spawning gravel in amounts greater than 30 percent, the embryo survival rate can be reduced to as low as 28 percent (Raleigh et al. 1984).

Table C-1 Criteria for rating fish habitat quality.

Parameter (source)	Habitat Quality Rating		
	Poor	Fair	Good
Spawning habitat			
Embeddedness (Martin 1996)	> 60 percent of sites with embeddedness > 30 percent	> 60 percent of sites with embeddedness < 30 percent	> 60 percent of sites with embeddedness < 5 percent
Rearing habitat			
Percentage pool area (Raleigh et al. 1984)	< 20 percent or > 70 percent	20 - 30 percent	30 - 70 percent
Pool depth and cover class (similar to Raleigh et al. 1984)	> 30 percent are < 7" deep and < 30 percent are LWD-formed	> 30 percent are > 7" deep and 30 - 60 percent are LWD-formed	> 60 percent are > 28" deep and > 60 percent are LWD-formed
Dominant substrate for food production (Raleigh et al. 1984)	Gravel-dominant and sand-subdominant or boulder-dominant	Gravel-dominant and cobble-subdominant or cobble-dominant and boulder-subdominant	Cobble-dominant and gravel-subdominant
LWD (Martin 1996)	< 1 pieces/channel width	1 - 2 pieces/ channel width	> 2 pieces/ channel width

Rearing Habitat

The following rearing habitat parameters were rated according to the criteria shown in Table C-1: percentage pool area, pool depth and cover class, dominant and subdominant substrate, and LWD. Pools are important for providing resting areas and refuge for juvenile fish; pool depth influences the area available to fish for refuge. Cover class is dependent on whether a pool is formed by LWD; the presence of LWD in pools increases the amount of cover available to fish for refuge. In addition to providing cover, LWD helps to form pool habitat by influencing

channel hydraulics. Dominant and subdominant substrate types influence food production; a substrate that is cobble-dominant and gravel-subdominant provides the best habitat for maintaining a diverse invertebrate population.

Results

The results of the habitat unit survey are presented in Table C-2 and the habitat quality ratings are presented in Table C-3.

Rearing Habitat Quality

Percentage pool area is rated good for Reaches 1, 2, and 4. Percentage pool area for Reach 3, which has a regime channel and consequently a naturally low number of pools, is rated fair. The low amount of pool area in Reach 3 is partly a function of the low gradient and the low amount of LWD.

Pool depth and cover class is rated fair for Reaches 1 and 4. Reach 2 has a fair to good rating for pool depth and cover class because the majority of pools in this reach have depths less than 45 inches. The rating for pool depth and cover class for Reach 3 was poor. Pool depth is directly related to stream size; the pools in Reach 3 are naturally shallow because the stream width in this reach is less than 10 ft.

Dominant and subdominant substrate for food production is rated poor for Reaches 1, 2, and 3 because the dominant substrate in these three reaches is sand. Reach 4 has a good rating for dominant and subdominant substrate because the dominant substrate in this reach is cobble, with gravel as the subdominant substrate. This substrate type is good for invertebrate communities.

LWD is rated good for Reaches 1, 2, and 4, and fair for Reach 3.

Table C-2 Habitat conditions in Swan Creek during summer 1999.

	Reach 1	Reach 2	Reach 3	Reach 4
Channel type	Pool-riffle	Pool-riffle	Regime	Pool-riffle
Gradient range (percent)	1	1	< 1	1
Survey length (ft)	884	369	102	275
Mean bankfull width (ft)	19.2	15.4	9.8	16.2
Percentage of pool tailouts with resident trout spawning gravel	58	15	50	25
Percentage of spawning gravel with embeddedness of				
< 30 percent	21	50	0	0
> 30 percent	79	50	100	100
Number of pools	22	13	2	8
Number of riffles	14	7	4	7
Percentage pool area	56	57	26	32
Pool spacing	2.1	1.8	5.2	2.1
Percentage of pools with residual depth of				
0-7 inches	17	23	0	0
7-14 inches	33	8	50	88
14-28 inches	25	38	50	13
28-45 inches	21	31	0	0
> 45 inches	4	0	0	0
Percentage of pools with LWD as primary former	50	85	0	50
Dominant/ subdominant substrate	Sand/gravel	Sand/fines	Sand	Cobble/gravel
LWD pieces per channel width	7.6	8.1	1.4	2.9
Total pieces of LWD	352	193	15	50

Table C-3 Habitat quality ratings for the four reaches surveyed in Swan Creek during the summer of 1999.

Parameter	Habitat Quality Rating			
	Reach 1	Reach 2	Reach 3	Reach 4
Spawning habitat				
Embeddedness	poor	fair	poor	poor
Rearing habitat				
Percentage pool area	good	good	fair	good
Pool depth and cover class	fair	fair to good	poor to fair	fair
Dominant substrate for food production	poor	poor	poor	good
LWD	good	good	fair	good
Overall habitat quality	fair	fair	poor to fair	good

Overall Habitat Quality

The pool-riffle channel type of Reach 1 provides good spawning and rearing habitat for fish, but the spawning gravel is highly embedded and the substrate type does not provide adequate habitat for food production. Therefore, the overall fish habitat rating for this reach is fair.

The overall salmonid habitat rating for Reach 2 is also fair because of the large percentage of sand and silt in the stream. Sand in the spawning areas causes the spawning gravel to be embedded, and as the subdominant substrate, the sand decreases invertebrate productivity. The depth of the pools (< 60 percent were < 28 inches deep) also contributed to the fair salmonid habitat rating.

The overall salmonid habitat rating for Reach 3, which has a regime channel, is poor to fair. Regime channels inherently have sandy bottoms and a low number of pools; Reach 3 has only one spawning habitat site and inadequate habitat for food production.

Reach 4 has a good overall salmonid habitat rating because the pool area, pool depth and cover, and amount of LWD present provides good habitat for salmonid rearing. Additionally, the substrate type provides good habitat for the invertebrate communities that provide a food source for fish. However, the spawning habitat in this reach is embedded and therefore does not provide good spawning habitat for fish living in this system.

Summary of Fish Habitat Conditions

The habitat conditions in Swan Creek between the outlet of the Pioneer Way culvert and the inlet of the Northern Pacific Railroad culvert lack suitable spawning habitat for fish living in this system. Additionally, this portion of Swan Creek does not have suitable substrate to foster invertebrate communities. Based on this information, the enhancement plan for Swan Creek will include the creation of a 530-ft, meandering spawning and rearing channel for coho and possibly cutthroat trout. This channel will connect Swan Creek with the Haire Wetland, and will provide coho and cutthroat trout rearing habitat for both summer and winter months. Off-channel winter and summer habitat has been shown to increase coho smolt production (Everest et al. 1985). The enhancement plan also will call for adding gravel and cobble substrate to Swan Creek to enhance the invertebrate populations, which will increase the food available to fish in the system. Additionally, a flow constrictor structure will be placed in conjunction with the cobble and gravel substrate to increase flow, which will flush out fine sediment and slow the sedimentation process.

Vegetation

Before conducting the site reconnaissance to characterize vegetation of the project area, Pentec reviewed the following sources of information to better understand land use, soils, geology, and site conditions within the Swan Creek watershed that may influence final design of the wetland and stream restoration:

- Pierce County Wetland Atlas (1987)
- Soil Survey of Pierce County, Washington (Zulauf, A.S. 1979)
- National Wetlands Inventory, Puyallup, Washington, Quadrangle (US Fish and Wildlife Service [USFWS] 1988)

Methods

Vegetation communities were distinguished by dominant plant species, habitat structure, topography, and apparent hydrologic regime. An area was identified as a wetland if it exhibited the following three characteristics: (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland

hydrology. Wetland plant communities were classified according to the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). The location and geographic extent of each community was determined by visual estimation and the use of a base map carried during the field investigation. Identification of some plant communities as wetlands is tentative, and will be confirmed using the information gathered during the jurisdictional wetland delineation performed by the City of Tacoma.

Although these plant communities are represented as distinct units, community boundary lines are approximate and are not always abrupt or distinct in the field. This is due to interspersion of plant species between adjacent vegetation communities. In addition, the degree to which the vegetation communities are distinguished from each other varies across the site.

Results

The Haire Wetland and riparian vegetation associated with Swan Creek cover most of the site. In total, eight plant communities were identified within the project area (Figure C 1). The communities classified as wetland appeared to meet the criteria for hydrophytic vegetation, hydric soils, and wetland hydrology. The general characteristics of these communities, including plant community composition, topography, soils, and hydrology, are described in this section. In addition, the wildlife habitat and known or likely species present on the site are discussed.

Community A

Community A is an approximately 1-acre upland area located in the southernmost portion of the site. This community is bounded by Pioneer Way to the south and west and Swan Creek to the east.

Much of the area contains a mature, second-growth forest dominated by broad-leaved deciduous trees. It has a fairly open canopy (approximately 50 percent cover) and little undergrowth due in part to the area's abundant dirt and gravel driveways. Black cottonwood (*Populus trichocarpa*) is dominant in this community, but scattered throughout are mature Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), and pine (*Pinus* sp.) trees, and a few immature big-leaf maple (*Acer macrophyllum*) and spruce (*Picea* sp.) trees. English ivy (*Hedera helix*) has infested a few of the mature cottonwood trees. Shrubs, including one-seeded hawthorn (*Crataegus monogyna*), cherry laurel (*Prunus laurocerasus*) and red-osier dogwood

(*Cornus sericea*) are scattered in this area too. Dense patches of invasive species, including Himalayan blackberry (*Rubus discolor*) and Scot's broom (*Cytisus scoparius*) occur in this community. One patch of Himalayan blackberry is adjacent to Swan Creek. Several large black cottonwood snags also exist in this area. These will either be saved as standing snags or possibly cut down and used as habitat features in Community B (see below). In addition, this community includes a small area dominated by bentgrass (*Agrostis* sp.) and tall fescue (*Lolium arundinaceum* formerly *Festuca arundinacea*).

Three structures exist within this community, including an approximately 2,500-ft² smokehouse, an approximately 120-ft² gray shack, and an approximately 1,500-ft² white shack. In addition, an approximately 400-ft² debris pile consisting of wood, concrete, and some kitchen appliances lies in an open area just north of the white shack. The smokehouse is off site.

Soil in this community includes fill material from previous development as well as what appear to be well-drained native sandy loam soils. In driveways and around structures, the soil is dense and compacted. Although lower-lying portions of this area adjacent to Swan Creek may occasionally flood from overbank flows, there was no evidence of hydric soil development anywhere in this community.

Community B

Community B is an approximately 3-acre wetland community located in the center of the site. This community shares a boundary with every community except Community A.

Community B is primarily emergent persistent vegetation (PEM1), interspersed with aquatic bed (PAB) and what appear to be permanently inundated areas with unconsolidated bottom (PUB). Standing water appears to exist all year in the PUB portions of this wetland, though water level seems to fluctuate throughout the year. The dominant plant species in the emergent areas are mild waterpepper (*Polygonum hydropiperoides*) and yellow iris (*Iris pseudacorus*). A few other herbaceous plants exist in this community, including marsh cinquefoil (*Comarum palustre*), wool grass (*Scirpus atrocinctus*), and purple loosestrife (*Lythrum salicaria*). Common cattail (*Typha latifolia*), Sitka willow (*Salix sitchensis*), and water starwort (*Callitriche heterophylla*) also occur in shallow (< 2 ft) areas. Aquatic bed communities are dominated by yellow pondlily (*Nuphar lutea* ssp. *polysepala*) and small patches of floating-leaved pondweed

(*Potamogeton natans*), which are found in deeper, possibly permanently inundated areas (approximately 2 to 4 ft deep). Algal blooms were observed in some areas that appeared to be unvegetated and composed of unconsolidated bottom substrate, possibly mud. Pacific willow (*Salix lasiandra*), Sitka willow, hardhack (*Spiraea douglasii*), and red-osier dogwood occur along the shore of the Haire Wetland, on small islands or isolated patches, and in what appear to be seasonally inundated areas along the sides of the wetland.

The small islands or isolated patches also supported immature (or stunted) red alder, and mature salmonberry (*Rubus spectabilis*), lady fern (*Athyrium filix-femina*), bentgrasses (*Agrostis* sp.), and bittersweet nightshade (*Solanum dulcamara*). The largest red alder is approximately 35 ft tall and 0.75 ft diameter at breast height (dbh), but most are approximately 25 ft tall and about 0.25 ft dbh. Along the margin of this wetland exist a number of mature and immature black cottonwood trees, some of which are dead and exist as snags. The largest black cottonwood is a decadent specimen on the western shore that has only a few live branches and is approximately 130 ft tall and over 4 ft dbh. Most of the black cottonwoods on the west shore of the Haire Wetland are about 100 ft tall and 1.5 to 2 ft dbh. Floating logs up to about 1-ft diameter are found throughout much of the wetland. Some of these appear to have been felled into the wetland by beaver. Although historic beaver activity was evident, Pentec did not observe any recent evidence of beaver activity, such as cuttings or chewings.

On the north end of the wetland, there are two, 100- to 125 ft arms of the wetland with somewhat different vegetation than the rest of Community B (see Figure C-1). The western arm possesses plant species and abundance similar to the main body of Community B, but has more black cottonwood snags. The eastern arm is moderately shaded by trees in adjacent communities and supports relatively less vegetation. Standing water appears fairly deep in the western arm, which is dominated by purple-fringed riccia (*Ricciocarpos natans*), a floating aquatic plant. The east arm is dominated by emergent vegetation such as narrowleaf bur-reed (*Sparganium emersum*) and common cattail. It is approximately 7 ft wide, has shallow water (approximately 0.5 ft) that is fairly turbid (visibility to 2 inches), and has deep, silty soil.

Soil below the ordinary high water mark (OHWM) throughout the wetland appears to be silt- and organic-rich and may best be classified as a muck. Soil above the OHWM appears to be a silt loam with little leaf litter or duff and moderate amounts of organic matter. The OHWM appeared to be approximately 6 inches above the water level observed during the time of the

investigation. The standing water was fairly turbid during the investigation, permitting visibility to only a 2-inch depth. However, clear pools existed among the more vegetated areas near the western shore. Iron bacteria was observed in some areas, suggesting that groundwater discharge may be an important source of wetland hydrology.

Community C

Community C is an approximately 1.5-acre upland community located in the southern portion of the site. It covers a portion of the east-facing slope below Pioneer Way, the north-facing slope south of Community B, and a portion of the gently sloping area separating Community B from Swan Creek. This community is bounded by Pioneer Way to the west and Community B to the east.

Community C is a mature, second-growth forest dominated by broad-leaved deciduous trees. It has a fairly open canopy (approximately 50 percent cover) dominated by mature and immature black cottonwood, red alder, and big-leaf maple. These trees are 20 to 100 ft tall and 0.3 to 2 ft dbh. Most mature trees are rooted upslope, but many immature and some mature black cottonwood and big-leaf maple trees exist near the edge of this community and Community B. Himalayan blackberry strongly dominates the understory below the canopy and in the relatively abundant open areas; however, there are well-developed patches of common snowberry (*Symphoricarpos albus*) throughout the area. Community C is not dominated by hydrophytic vegetation.

Both the east-facing and north-facing slopes are about 20 to 30 percent along much of their length. These slopes appear to consist of moderately well-drained sandy loam to silt loam soils.

Community D

Community D is an approximately 2.4-acre upland community located in the northwestern portion of the site. This community is bounded by Pioneer Way to the west and Communities B and E and the railroad tracks to the east. This community extends off site to the north.

Community D is a mature, second-growth forest dominated by broad-leaved deciduous trees. It has a relatively closed canopy (approximately 80 percent cover) dominated by mature big-leaf maple. A few mature black cottonwoods are scattered throughout the community. Both the

big-leaf maples and the black cottonwoods are about 80 to 100 ft tall and about 1 to 2 ft dbh. Many of the black cottonwoods are infested with English ivy. Several immature and mature black cottonwood and big-leaf maple trees exist along the edge of this community near the border of Community B. These trees are 70 to 100 ft tall with 1 to 2-ft dbh.

Beneath the forest canopy is a well-developed shrub stratum dominated by common snowberry. Also present in this stratum are Indian plum (*Oemleria cerasiformes*), Himalayan blackberry, thimbleberry (*Rubus parviflorus*), and red alder saplings. The herb layer, which is very sparse, is dominated by sword fern (*Polystichum munitum*) and trailing blackberry (*Rubus ursinus*).

Most of this community is situated on an east-facing slope that ranges in slope from approximately 5 to 30 percent. Soil in this community was similar to that observed in Community C.

Community E

Community E is an approximately 0.6-acre wetland community located in the northern portion of the site. This community is bounded by Communities B and D to the west and Community F, Swan Creek, and the train tracks to the east.

Community E is a mature, second-growth palustrine forested wetland (PFO1) dominated by broad-leaved deciduous trees. The canopy is dominated by mature black cottonwood and red alder and total vegetation cover is estimated to be over 100 percent. Cover is over 100 percent because of the different tiers of vegetation within this community, including shrubs and trees. The black cottonwood trees are 100 to 120 ft tall and 1 to 2 ft dbh, whereas the red alder trees are 80 to 100 ft tall and 1 to 2 ft dbh. There is also a well-developed midlevel stratum that is dominated by salmonberry. Because of the dense tree and shrub cover, there is no herb layer in this community.

The ground surface is fairly level, but shows evidence of overbank deposition near the creek and pit-and-mound topography farther from the creek. The soil appears to be a hydric silt loam. The source of wetland hydrology in this community appears to be seasonally high groundwater, but may also include periodic overbank flooding from Swan Creek.

Community F

Community F is an approximately 2-acre wetland community oriented parallel to Swan Creek. This community is bounded by Community B to the west and the train tracks to the east.

Community F is a mature, second-growth palustrine forested wetland dominated by broad-leaved deciduous trees. The canopy is dominated by mature Pacific willow, black cottonwood, and red alder trees. Cover is estimated to be over 100 percent. Cover is over 100 percent because of the different tiers of vegetation within this community, including herbs, shrubs, and trees. Most of the trees are 80 to 120 ft tall and 1 to 2-ft dbh. The midstory layer is fairly well developed and dominated by Sitka willow, but also contains common snowberry, Himalayan blackberry, and red-osier dogwood. Bittersweet nightshade is found growing on many of these shrubs, especially in the more open areas. Communities of herbaceous vegetation present, including reed canarygrass (*Phalaris arundinacea*) and marsh skullcap (*Veronica scutellata*), also occur in this area. Reed canarygrass is generally confined to more open areas, whereas marsh skullcap occurs in discrete patches in more shaded areas.

The ground surface is fairly level, but a berm produced by overbank deposition and incision exists near the creek, and pit-and-mound topography produced by tree-fall exists farther from the creek. The soil is likely hydric and appears to be a loam with moderate amounts of organic matter. Overbank flooding and seasonally high groundwater levels likely are the dominant sources of wetland hydrology.

Community G

Community G is composed of two separate wetland communities that cover approximately 1.2 acres. The northern portion is bounded by Community F to the west and south and the train tracks to the east. The southern portion is bounded by Community F to the west and the train tracks to the north.

Community G is an emergent wetland community dominated by persistent emergent vegetation (PEM1). Reed canarygrass is the only plant species found growing in this community. Several black cottonwood snags ranging from 20 to 100 ft in height were found in both the northern and southern areas containing this community. At least two small (15- to 25-ft-diameter) pools of open water up to 3 ft deep were observed in this community.

The topography in these areas is relatively level and may be the result of flood plain processes. The soil appears to be a silt loam. The source of wetland hydrology in this community appears to be from seasonally high groundwater table and periodic overbank flooding from Swan Creek.

WILDLIFE HABITAT

Swan Creek, the Haire Wetland complex (including Communities B, E, F, and G), and adjacent forested uplands (including Communities A, C, and D), support a diverse array of habitat for fish and wildlife. However, many of these habitats provide relatively limited value due, in part, to relatively low structural and habitat diversity. Dense communities of invasive species, including Himalayan blackberry and reed canarygrass, contribute to the relatively low structural diversity and diminished habitat values.

The wetland on site contains a number of different wetland vegetation classes and habitat types, including forested, emergent, and unconsolidated bottom. Also, there are some other specific habitat features within the wetland complex, including snags, LWD, and apparently permanently inundated areas (sometimes called open water). These features are most abundant in Community B. The relatively large size, edge habitat, and continuity with mature forested uplands likely provides habitat for many mammals, birds, reptiles, and amphibians commonly found in western Washington.

Results of the reconnaissance investigations done on the site were used to develop enhancement and restoration plans within the different communities. Proposed plantings of shrubs and trees were selected for their compatibility with existing vegetation and based on existing site conditions. In addition, plant species also were selected based on their ability to contribute to habitat diversity and complexity.

REFERENCES

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service, Office of Biological Services, Publication FWS/OBS-79/31, Washington, DC.

Everest, F.H., G.H. Reeves, J.R. Sedell, J. Wolfe, D. Hohler, and D.A. Heller. 1985. Abundance, behavior, and habitat utilization by coho salmon and steelhead trout in Fish Creek, Oregon, as influenced by habitat enhancement. Bonneville Power Administration, Portland, Oregon.

Hankin, D.G., and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Science 45:834-844.

Martin, D. 1996. Fish Habitat *in* Watershed analysis training. Washington State Department of Natural Resources, Forest Services Division, Olympia.

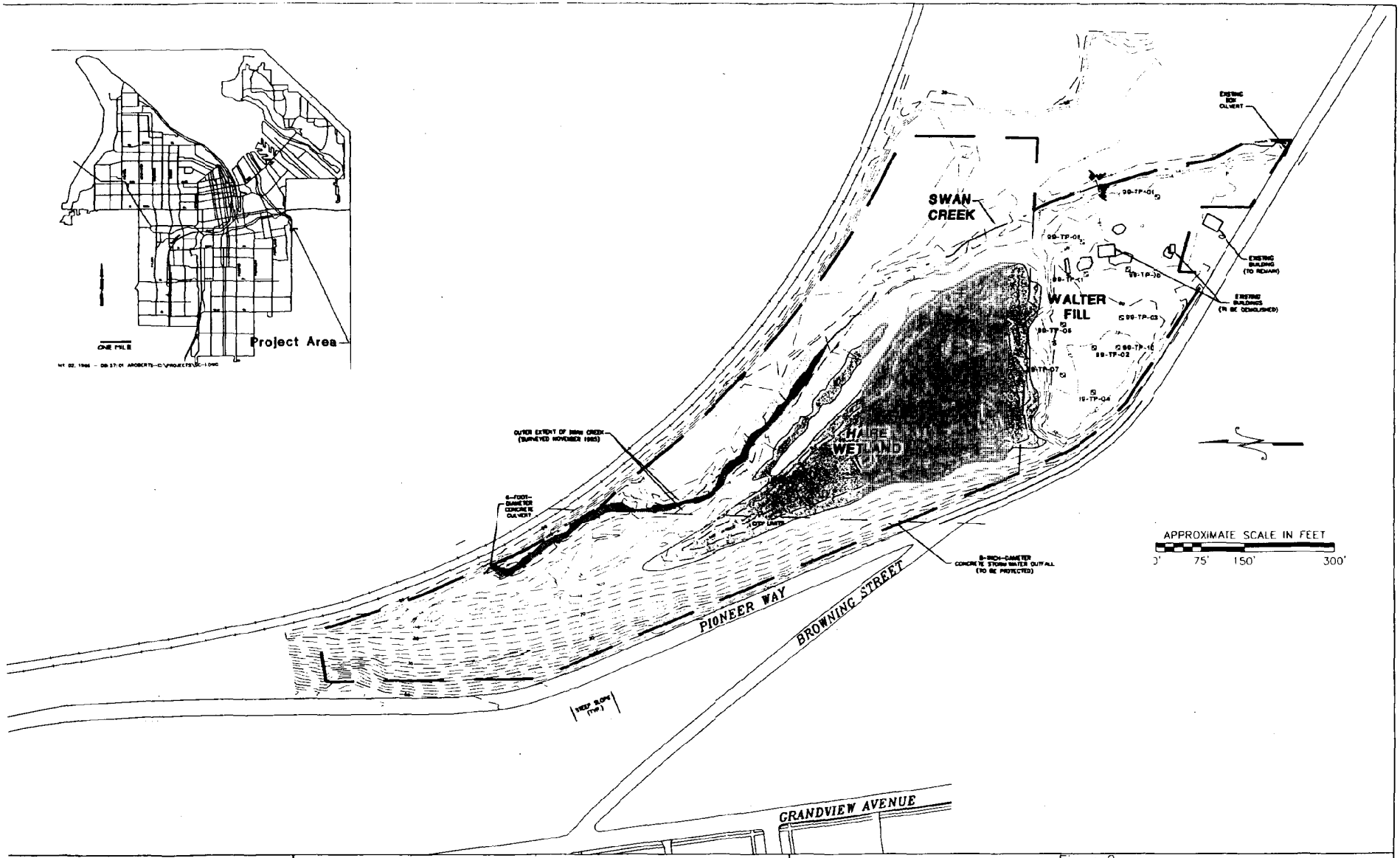
Montgomery, D.R., and J.M. Buffington. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Washington Timber/Fish/Wildlife, Technical Report TFW-SH10-93-002, Olympia, Washington.

Pierce County Wetland Atlas. 1987. Department of Land Use Services, Tacoma, Washington.

Raleigh, R.F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. US Department of the Interior, Fish and Wildlife Service, FWS/OBS-82/10.60.

Zulauf, A.S. 1979. Soil survey of Pierce County area, Washington. US Department of Agriculture, Soils Conservation Service, Washington, DC.

Attachment— Project Constructions Plans



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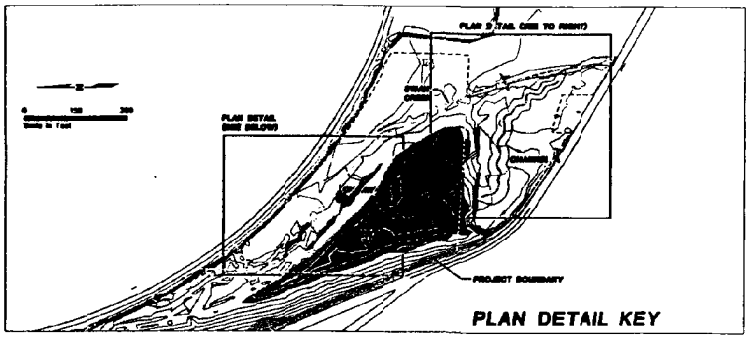
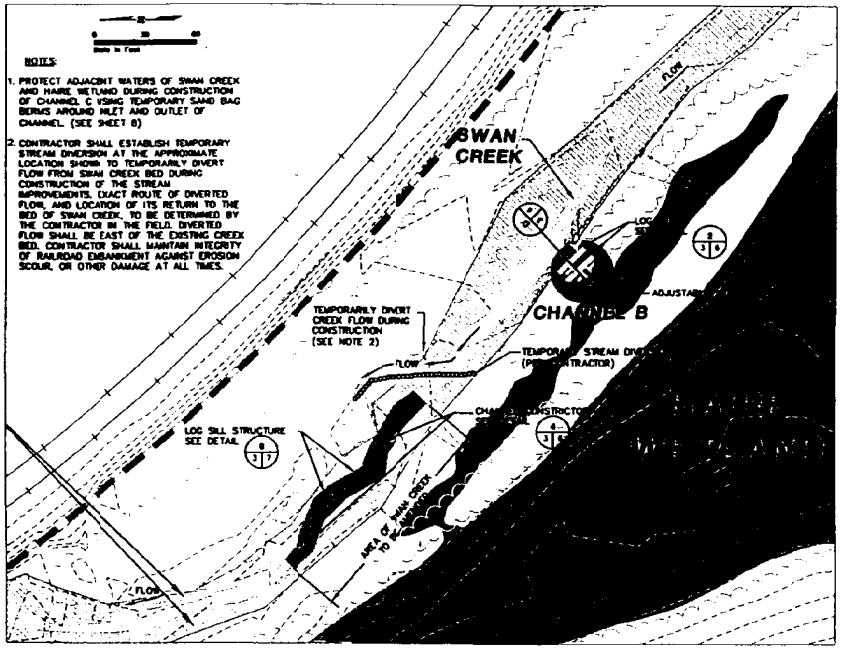
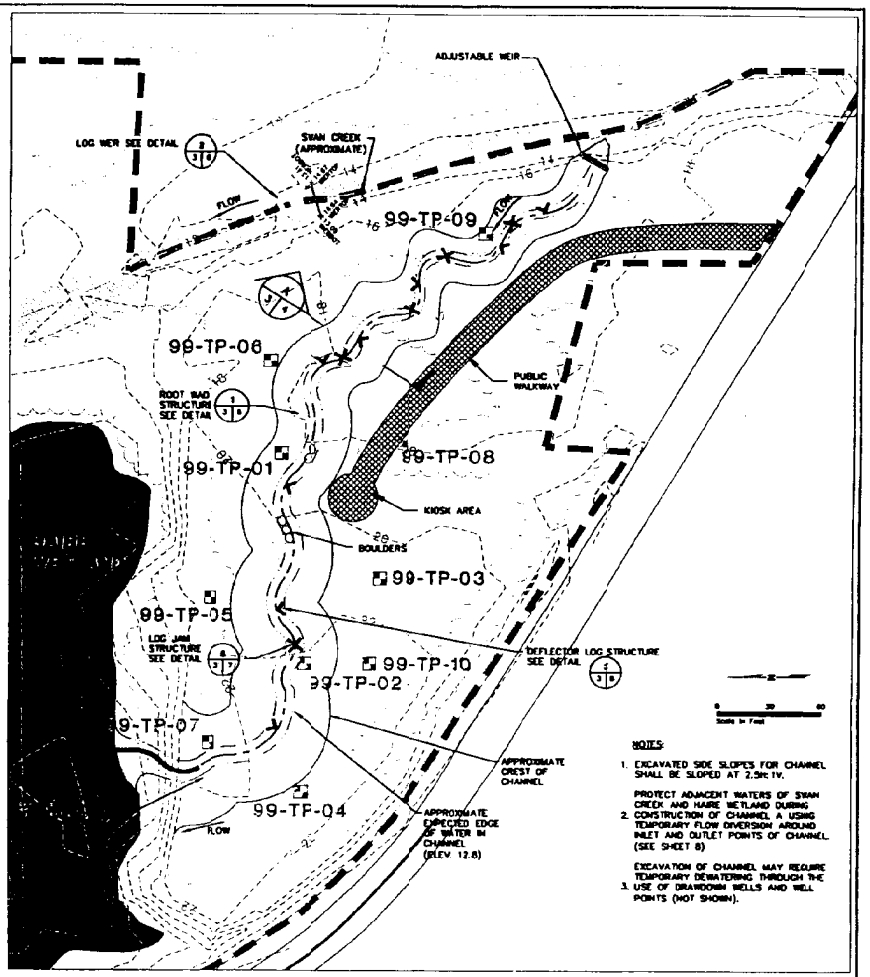
for City of Tacoma

Figure 2
Design plan





PLAN DETAIL
CHANNEL B AND STREAM IMPROVEMENTS



PLAN DETAIL
EXCAVATED POND AND CHANNEL A

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SWAN CREEK STREAM RESTORATION PROJECT
GRADING PLAN Figure 4

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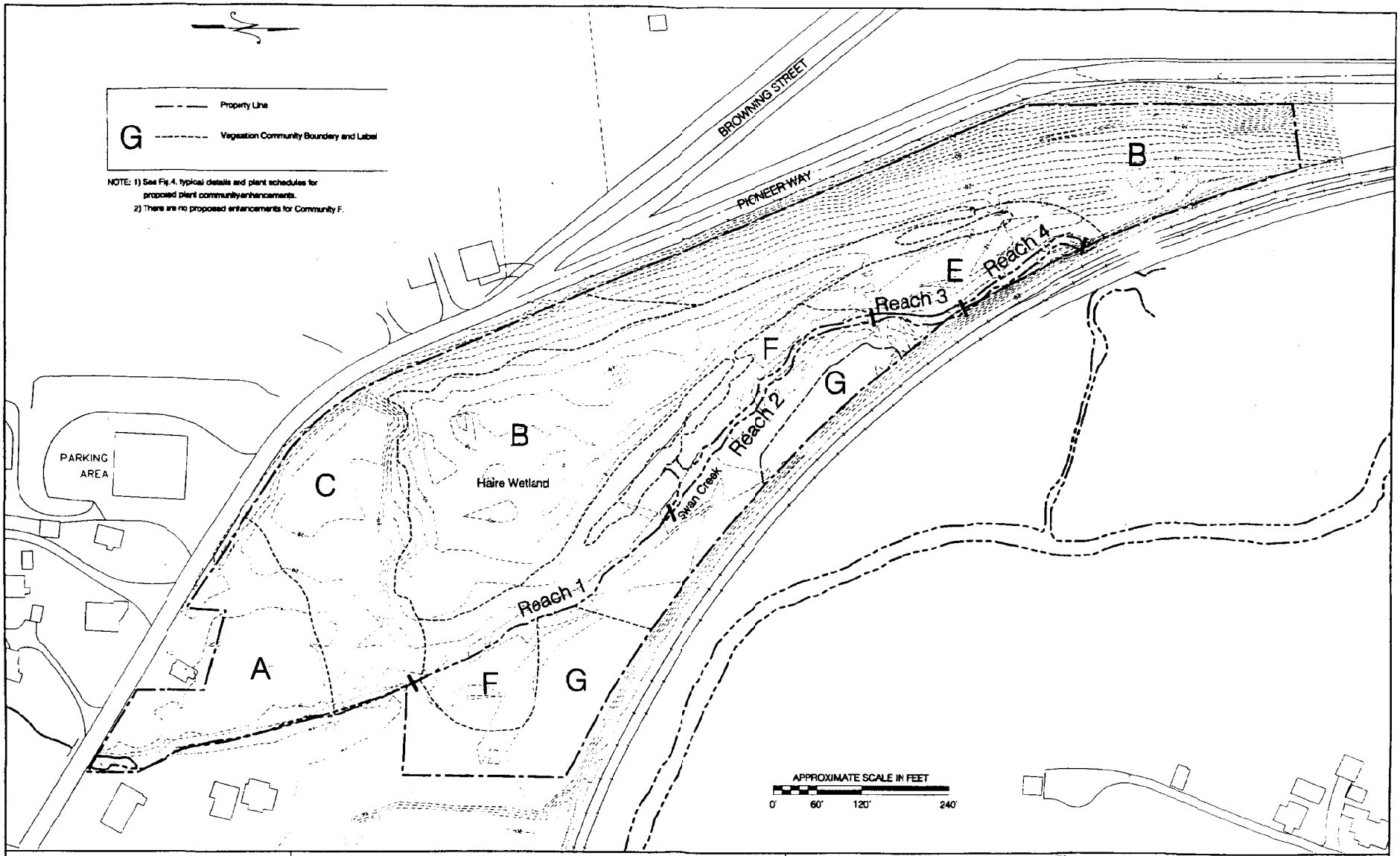
24x36	AS SHOWN	9/9/99	DRAFT	J-7197	3 of 8



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Swan Creek; Haire Wetland Restoration
Tacoma, Washington
for City of Tacoma

Figure 5

Existing plant communities and reach locations.

Tacoma

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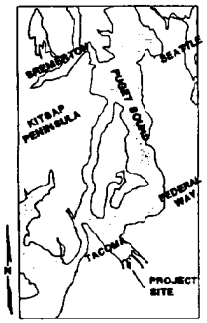
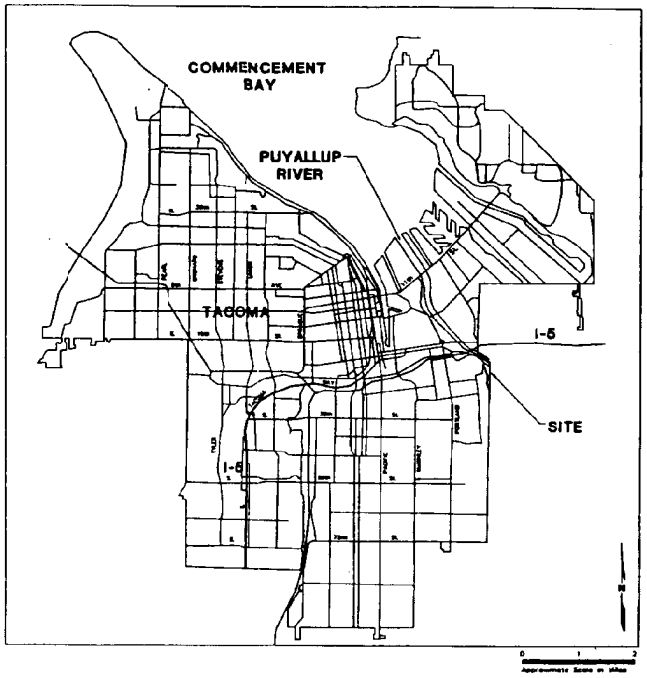


AREA MAP



VICINITY MAP

WORK ORDER: DC 1094

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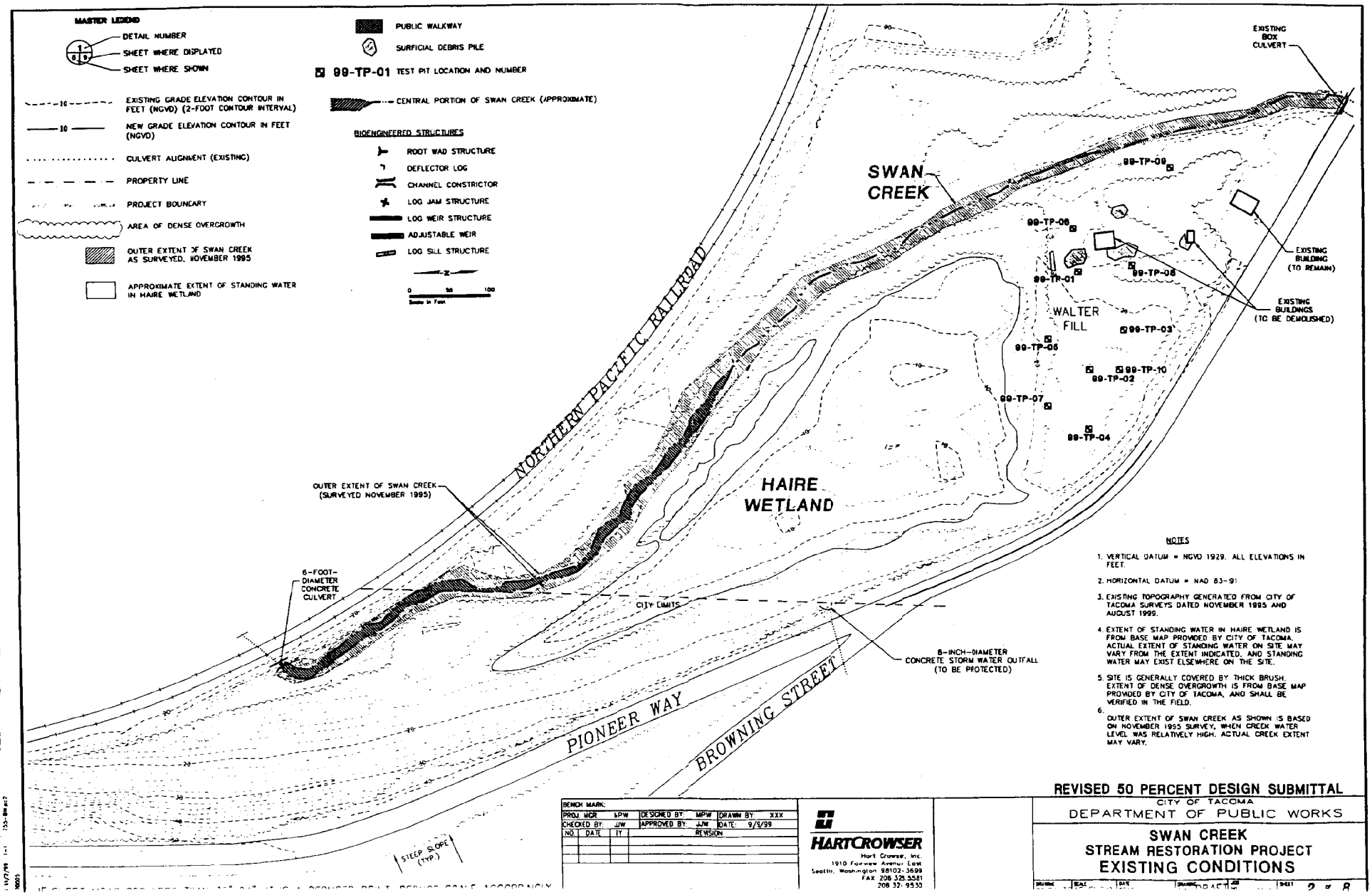
SWAN CREEK
STREAM RESTORATION PROJECT
TITLE SHEET


MASTER LEGEND
DETAIL NUMBER
SHEET WHERE DISPLAYED
SHEET WHERE SHOWN
EXISTING GRADE ELEVATION CONTOUR IN FEET (NGVD) (2-FOOT CONTOUR INTERVAL)
NEW GRADE ELEVATION CONTOUR IN FEET (NGVD)
CULVERT ALIGNMENT (EXISTING)
PROPERTY LINE
PROJECT BOUNDARY
AREA OF DENSE OVERGROWTH
OUTER EXTENT OF SWAN CREEK AS SURVEYED, NOVEMBER 1995
APPROXIMATE EXTENT OF STANDING WATER IN HAIRE WETLAND
PUBLIC WALKWAY
SURFICIAL DEBRIS PILE
99-TP-01 TEST PIT LOCATION AND NUMBER
CENTRAL PORTION OF SWAN CREEK (APPROXIMATE)
BIOENGINEERED STRUCTURES
ROOT WAD STRUCTURE
DEFLECTOR LOG
CHANNEL CONSTRICTOR
LOG JAM STRUCTURE
LOG WEIR STRUCTURE
ADJUSTABLE WEIR
LOG SILL STRUCTURE
0 50 100
Scale in Feet
SWAN CREEK
NORTHERN PACIFIC RAILROAD
HAIRE WETLAND
WALTER FILL
EXISTING BOX CULVERT
EXISTING BUILDING (TO REMAIN)
EXISTING BUILDINGS (TO BE DEMOLISHED)
99-TP-09
99-TP-06
99-TP-08
99-TP-01
99-TP-03
99-TP-05
99-TP-10
99-TP-02
99-TP-07
99-TP-04
OUTER EXTENT OF SWAN CREEK (SURVEYED NOVEMBER 1995)
6-FOOT-DIAMETER CONCRETE CULVERT
CITY LIMITS
8-INCH-DIAMETER CONCRETE STORM WATER OUTFALL (TO BE PROTECTED)
PIONEER WAY
BROWNING STREET
STEEP SLOPE (TYP.)
NOTES
1. VERTICAL DATUM = NGVD 1929. ALL ELEVATIONS IN FEET.
2. HORIZONTAL DATUM = NAD 83-91
3. EXISTING TOPOGRAPHY GENERATED FROM CITY OF TACOMA SURVEYS DATED NOVEMBER 1995 AND AUGUST 1999.
4. EXTENT OF STANDING WATER IN HAIRE WETLAND IS FROM BASE MAP PROVIDED BY CITY OF TACOMA. ACTUAL EXTENT OF STANDING WATER ON SITE MAY VARY FROM THE EXTENT INDICATED, AND STANDING WATER MAY EXIST ELSEWHERE ON THE SITE.
5. SITE IS GENERALLY COVERED BY THICK BRUSH. EXTENT OF DENSE OVERGROWTH IS FROM BASE MAP PROVIDED BY CITY OF TACOMA, AND SHALL BE VERIFIED IN THE FIELD.
6. OUTER EXTENT OF SWAN CREEK AS SHOWN IS BASED ON NOVEMBER 1995 SURVEY, WHEN CREEK WATER LEVEL WAS RELATIVELY HIGH. ACTUAL CREEK EXTENT MAY VARY.
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SWAN CREEK
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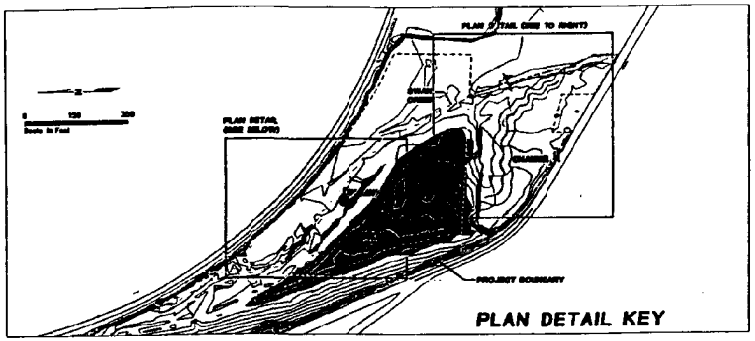
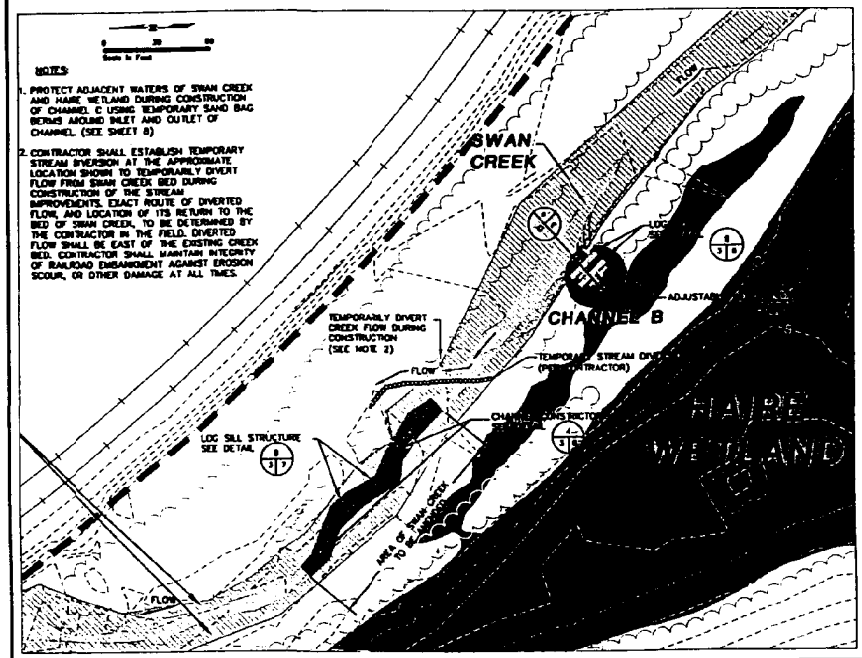
EXISTING CONDITIONS
SHEET 2 of 8





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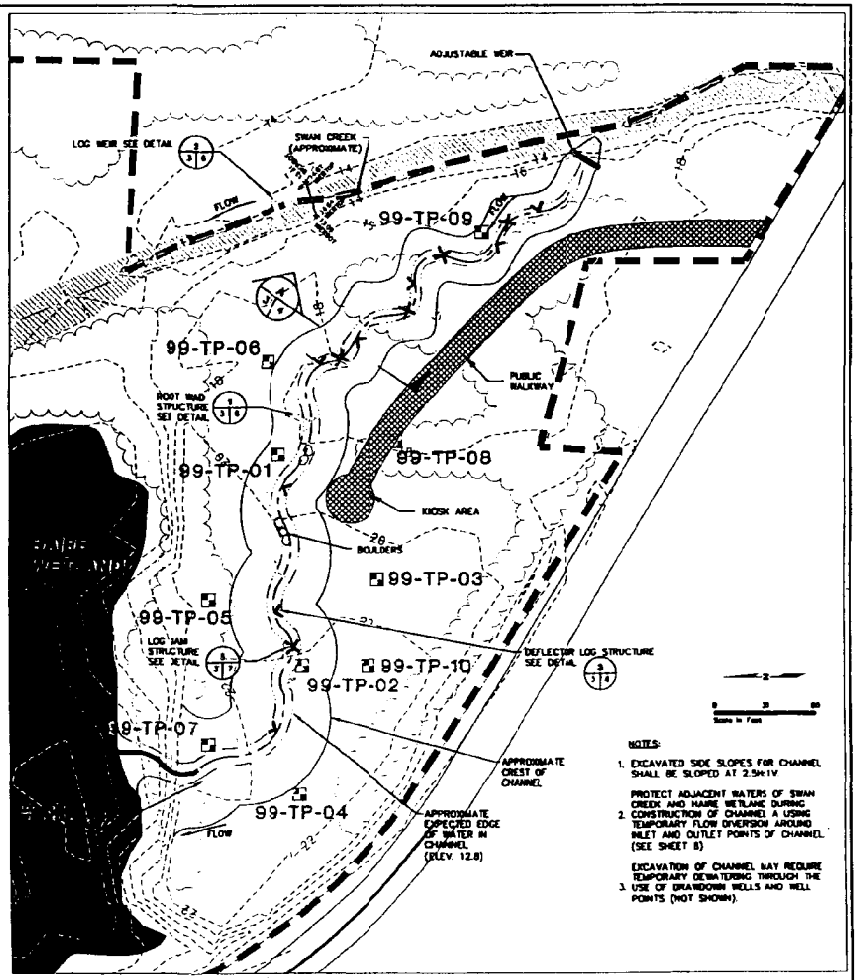
CHANNEL B AND STREAM IMPROVEMENTS



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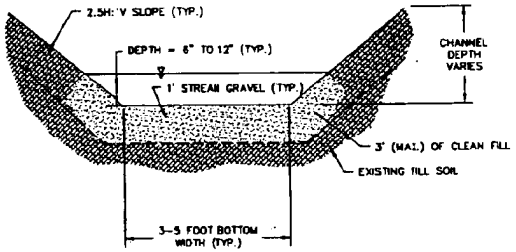
STREAM RESTORATION PROJECT
GRADING PLAN Figure 4

DWG 24x36 | SCALE AS SHOWN | DATE 5/5/99 | TYPE DRAFT | JOB J-7157 | SHEET 3 of 8



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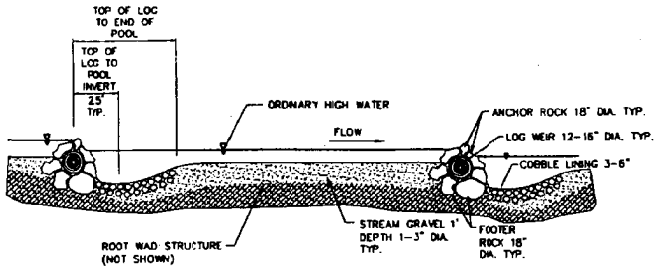

PARTIAL CROSS SECTION ALONG CHANNEL C (TYP.) (D 3|4)
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SWAN CREEK
STREAM RESTORATION PROJECT
CROSS SECTIONS

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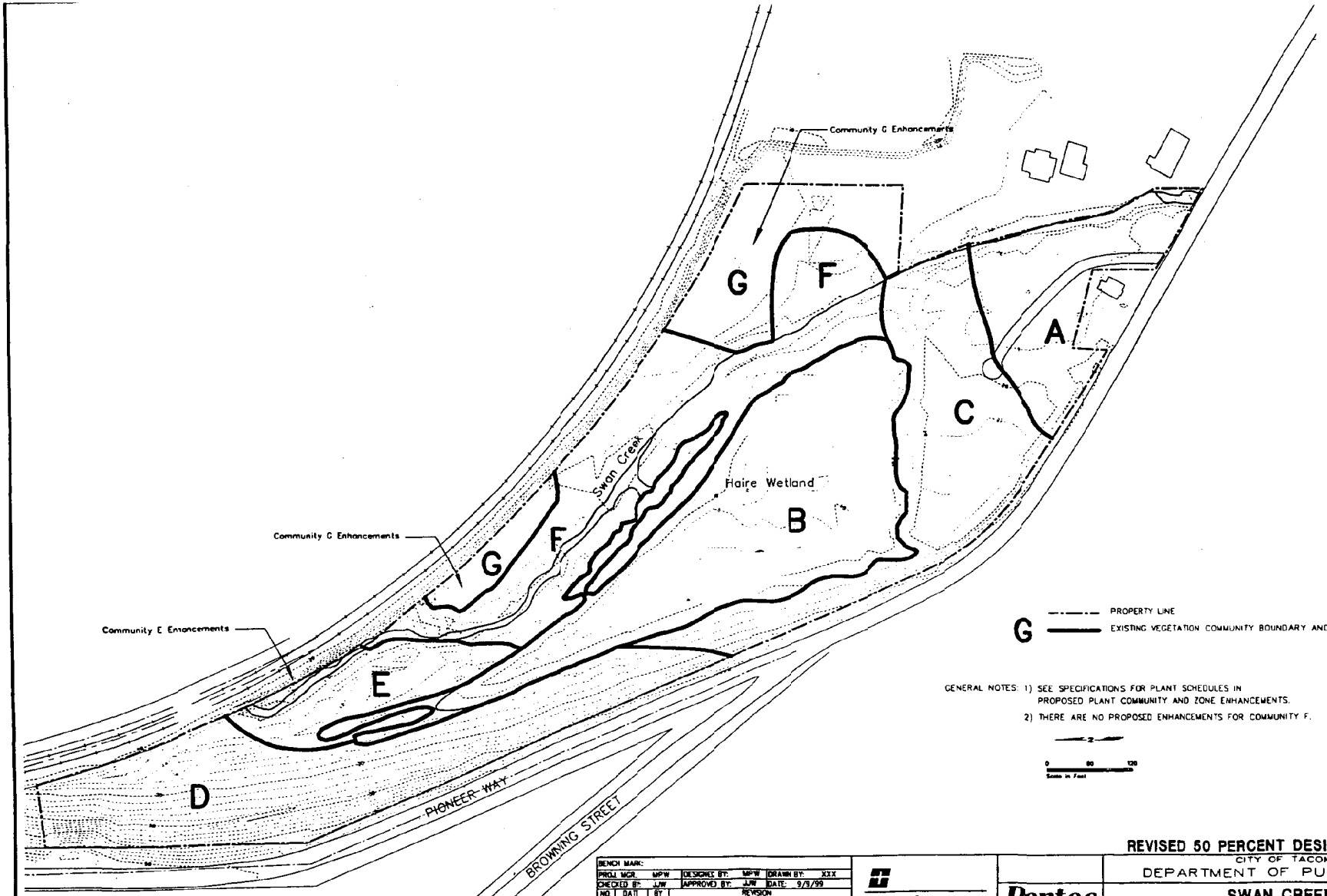

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REVISED 50 PERCENT DESIGN SUBMITTAL

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SWAN CREEK STREAM RESTORATION PROJECT
PLANTING PLAN

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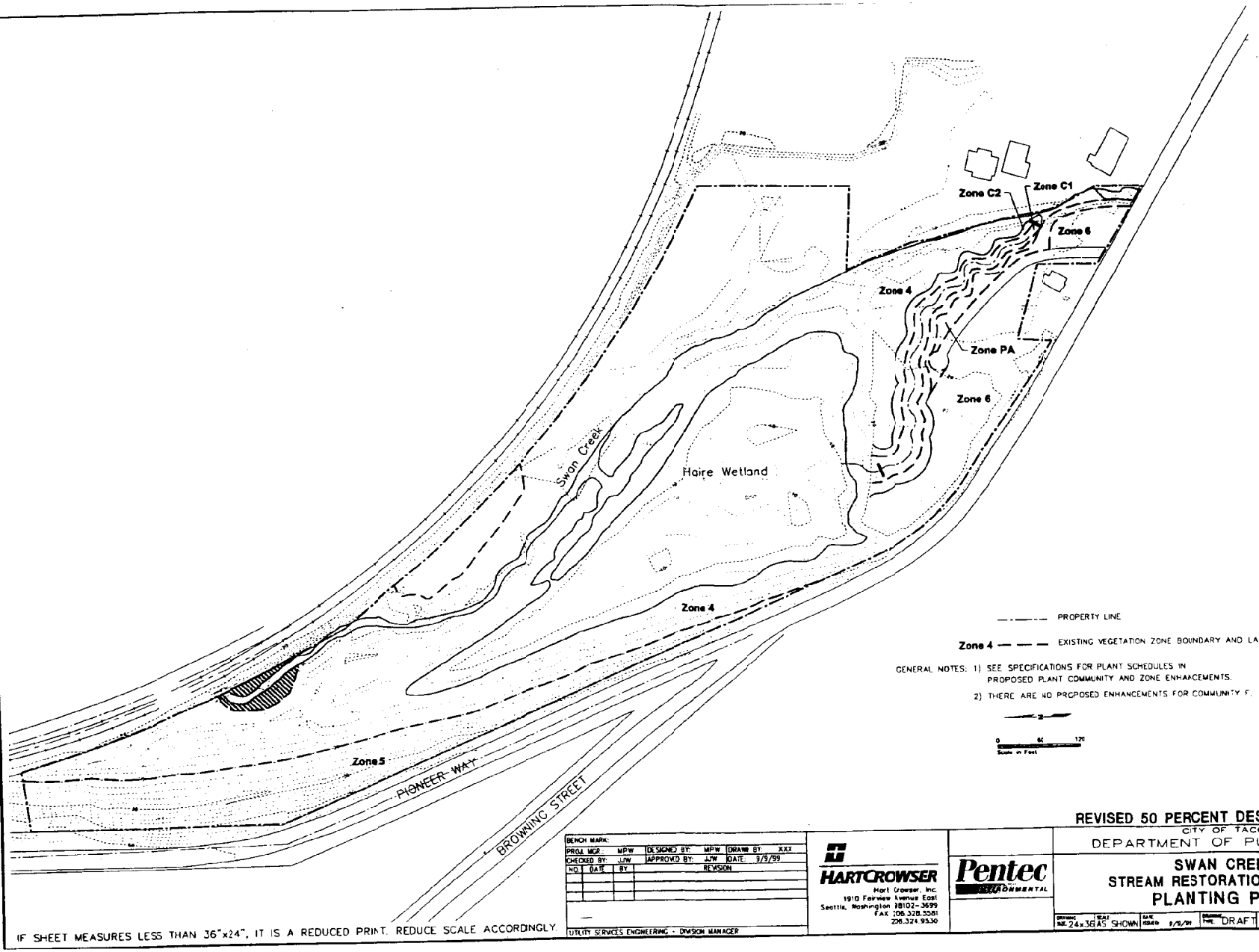

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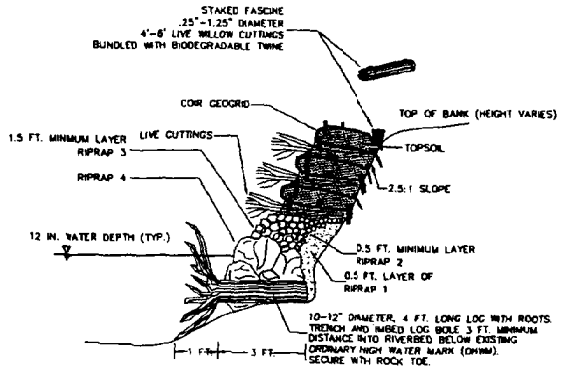
PLANTING PLAN

DRAWING SIZE 24x36 | SCALE AS SHOWN | DATE ISSUED 3/9/99 | DRAWING TYPE DRAFT | JOB NO. J-7197 | SHEET 5B OF 8



ROOT WAD STRUCTURE
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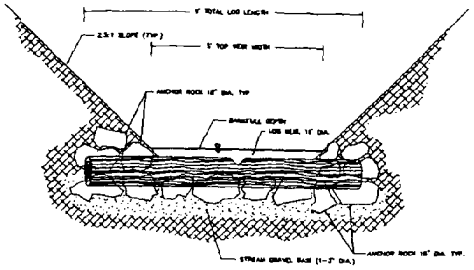

CROSS SECTION - LOG WEIR
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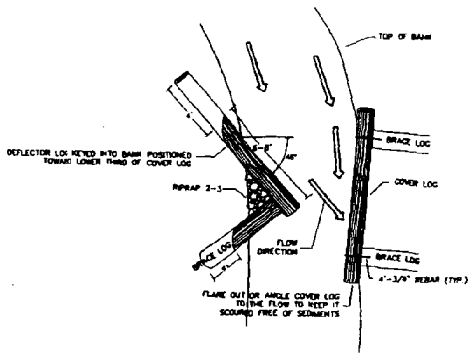
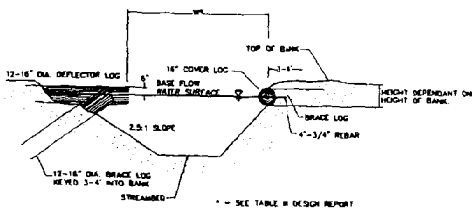
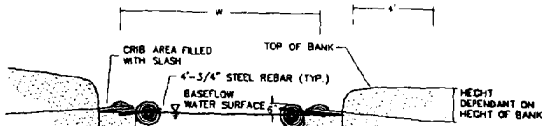


PLAN VIEW

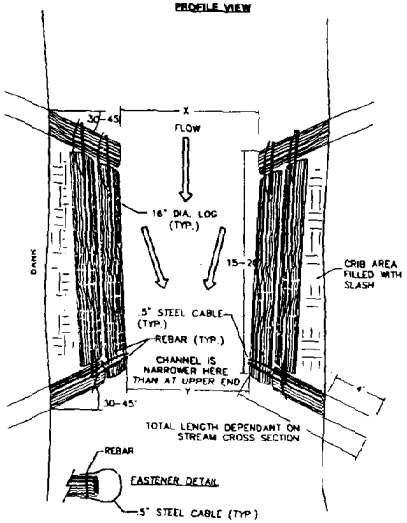


PROFILE VIEW

DEFLECTOR LOG STRUCTURE
NOT TO SCALE



PROFILE VIEW



CHANNEL CONSTRICTOR
NOT TO SCALE

BENCH MARK:						
PROJ. MGR.:	MPW	DESIGNED BY:	MPW	DRAWN BY:	XXX	
CHECKED BY:	JMW	APPROVED BY:	JMW	DATE:	9/9/09	
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CITY OF TACOMA
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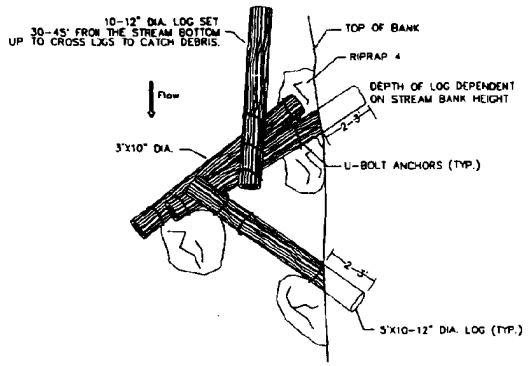
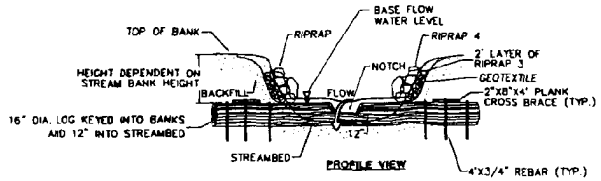
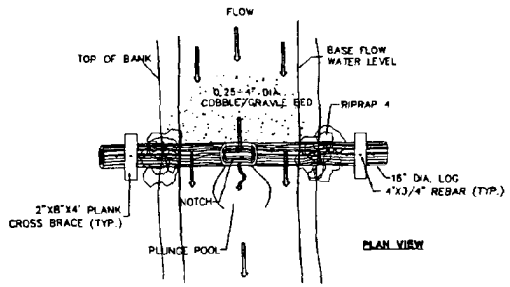
SWAN CREEK
STREAM RESTORATION PROJECT
BIOENGINEERING DETAILS (1 OF 2)



LOG JAM STRUCTURE (5/3|7)
NOT TO SCALE





LOG SILL STRUCTURE (6/3|7)
NOT TO SCALE

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SWAN CREEK
STREAM RESTORATION PROJECT
BIOENGINEERING DETAILS (2 OF 2)

DRAWING SIZE: 24x36	SCALE: AS SHOWN	DATE ISSUED: 9/9/99	DRAWN BY: DRAFT	JOB NO.: J-7187	SHEET: 7 of 8

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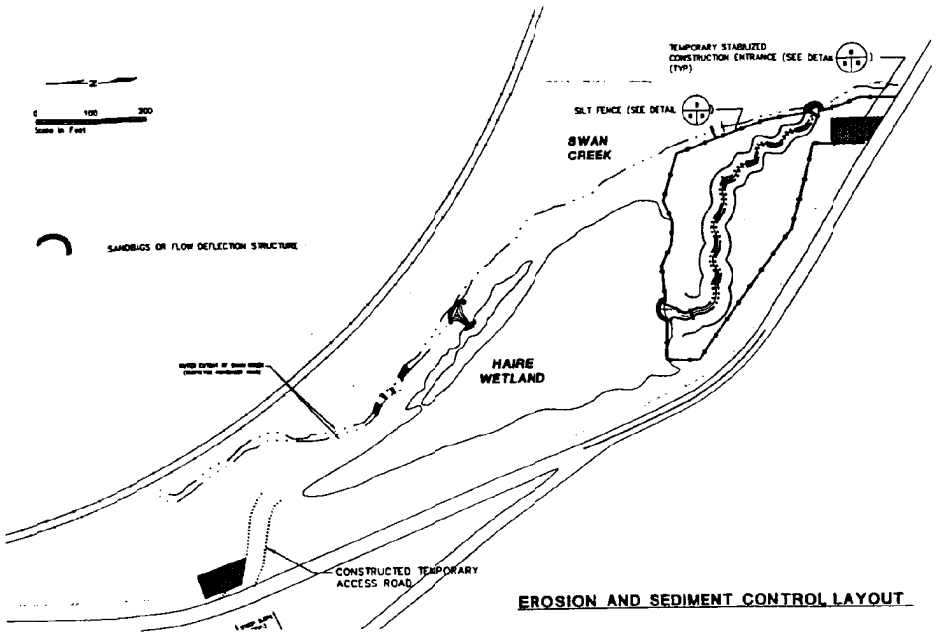
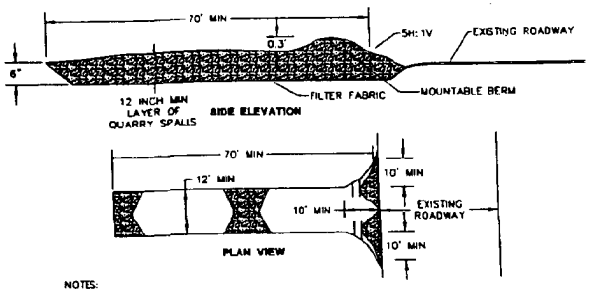


EROSION AND SEDIMENT CONTROL LAYOUT

GENERAL NOTES:

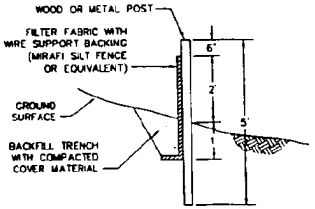
1. THE EROSION AND SEDIMENT CONTROL LAYOUT AND DETAILS SHOWN IN THESE PLANS ADDRESS PROCEDURES, EQUIPMENT, AND MATERIALS NECESSARY TO CONTROL AND MINIMIZE EROSION, LOSS OF SEDIMENTS, AND ENTRY OF SEDIMENT INTO SWAN CREEK AND HAIRE WETLAND DURING REMEDIATION WORK.
2. SILT FENCING SHALL BE ESTABLISHED IMMEDIATELY DOWNSLOPE OF ALL CONSTRUCTION ACTIVITIES, INCLUDING CLEARING, EXCAVATION, AND SOIL PLACEMENT, TO PREVENT TRANSPORT OF SOIL TO SWAN CREEK AND THE SURROUNDING ENVIRONMENT.
3. THE AREAS AVAILABLE FOR STOCKPILING OF IMPORTED OR EXCAVATED SOILS ARE INDICATED ON THIS SHEET. ALL SOIL STOCKPILES SHALL BE COVERED BY SECURED PLASTIC SHEETING TO MINIMIZE EROSION AND LOSS OF SOILS DUE TO PRECIPITATION OR WIND.
4. STOCKPILE AND/OR STAGING AREAS SHALL NOT ENCROACH WITHIN 20 FEET OF THE CREST OF THE SLOPE TO HAIRE WETLAND, OR EXCAVATED SIDE SLOPES, OR WITHIN 20 FEET OF SWAN CREEK.
5. BLOWING DUST IN DRY WEATHER CONDITIONS SHALL BE MINIMIZED BY SPRAYING ALL ACTIVE AREAS OF EXPOSED SOIL WITH WATER.
6. ALL INGRESS AND EGRESS TO THE PROJECT SIT BY HEAVY EQUIPMENT AND TRUCK/TRAILERS SHALL BE CONTROLLED UTILIZING THE STABILIZED CONSTRUCTION ENTRANCES, LOCATED AS SHOWN ON THIS SHEET.
7. CONTRACTOR SHALL PLACE SANDBAGS OR OTHER FLOW DEFLECTION STRUCTURES AS SHOWN TO KEEP WATER FROM ENTERING THE EXCAVATED AREAS.
8. TEMPORARY ACCESS ROAD TO BE CONSTRUCTED BY LAYING DOWN 12 INCHES OF QUARRY SPALLS OVER A LAYER OF FILTER FABRIC, OVER THE CLEARED SUBGRADE, WHILE MINIMIZING REMOVAL OF TREES. EXACT ROUTE OF TEMPORARY ACCESS ROAD TO BE DETERMINED IN THE FIELD BY THE CONTRACTOR.
9. ALL TEMPORARY EROSION AND SEDIMENT CONTROLS AND TEMPORARY ACCESS ROAD(S) SHALL BE FULLY REMOVED AND SITE RESTORED TO ITS PREVIOUS CONDITION FOLLOWING COMPLETION OF CONSTRUCTION.



NOTES:

1. MUST EXTEND FULL WIDTH OF INGRESS AND EGRESS OPERATION.
2. VEHICLES AND HEAVY EQUIPMENT LEAVING THE SITE WITH THE POTENTIAL TO TRACK SOIL OR DEBRIS ONTO PIONEER WAY SHALL BE CLEANED WITH A PRESSURE WASHER WHILE IN THE STABILIZED CONSTRUCTION ENTRANCE.
3. AT THE END OF THE PROJECT, PIONEER WAY SHALL BE CLEANED USING A STREET SWEEPER, WITHIN APPROX. 200 FEET BEYOND BOTH EDGES OF EACH CONSTRUCTION ENTRANCE.

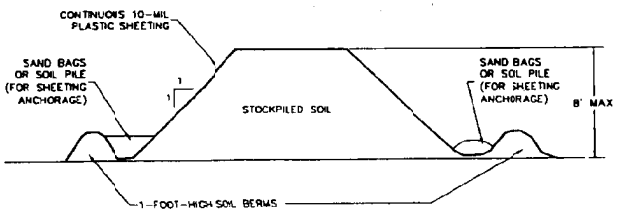
TEMPORARY STABILIZED CONSTRUCTION ENTRANCE (8 | 8 | 6)
NOT TO SCALE



NOTES:

1. WOOD OR METAL POSTS SHALL BE SPACED NO MORE THAN 6 FEET APART.
2. EXCAVATE TRENCH 12" DEEP TO BURY BASE OF FILTER FABRIC. BACKFILL TRENCH WITH COMPACTED COVER MATERIAL.

CROSS SECTION - SILT FENCE (TYP.) (8 | 8 | 6)
NOT TO SCALE



NOTES:

1. PLACE SAND BAGS OR SOIL PILES AS NECESSARY TO ANCHOR SHEETING AGAINST WINDS, ETC.
2. SURROUND ENTIRE STOCKPILE PERIMETER WITH SOIL BERMS.

CROSS SECTION - TEMPORARY STOCKPILE (10 | 8 | 8)
NOT TO SCALE

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SWAN CREEK STREAM RESTORATION PROJECT
EROSION AND SEDIMENT CONTROL PLAN

DRAWING SIZE: 24x36	SCALE: AS SHOWN	DATE ISSUED: 9/9/99	DRAWING TYPE: DRAFT	JOB NO.: J-719	SHEET: 8 OF 8

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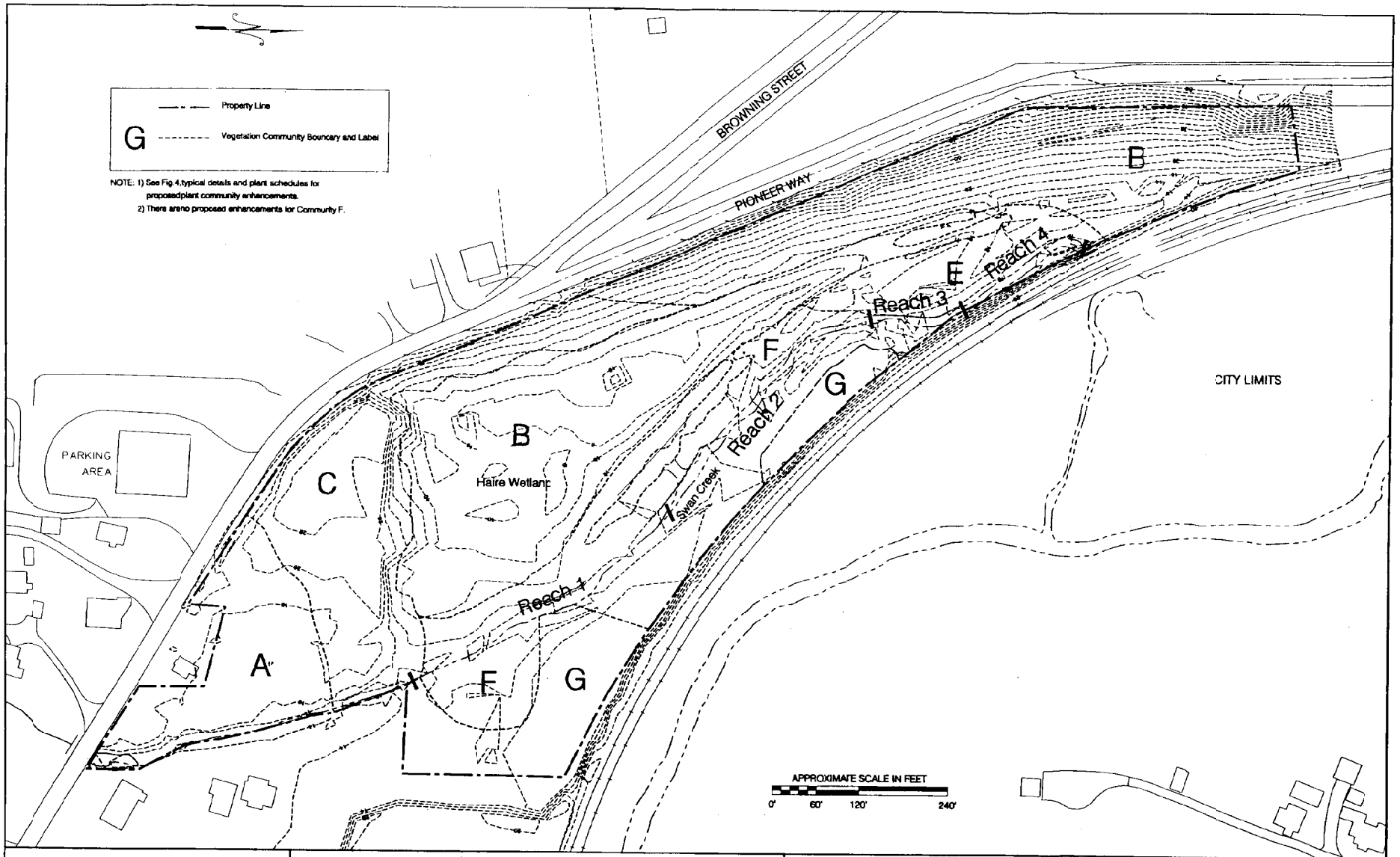

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(425) 775-4682

Swan Creek, Haire Wetland Restoration
Tacoma, Washington
for City of Tacoma

Figure C-1

Existing plant communities and reach locations.