DRAFT

Design of Swan Creek Stream and Wetland Enhancement

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April 11, 2000

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INTRODUCTION

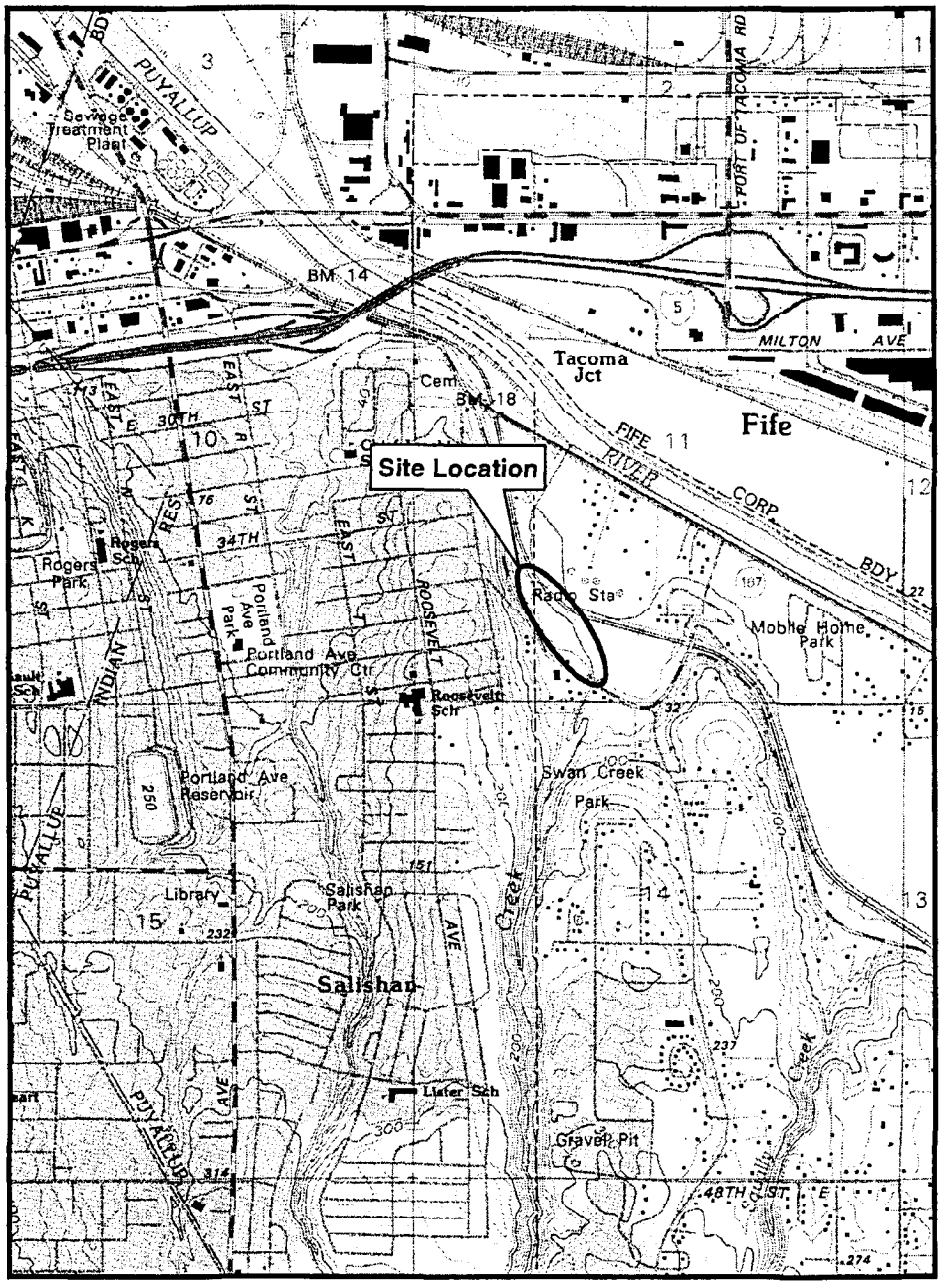
In 1997 the City of Tacoma produced a conceptual plan to restore and enhance a 12-acre site located in Section 11, Township 20N, Range 3E in Tacoma, Washington (Figures 1 and 2) (City of Tacoma 1997). This site contains a 3.0-acre wetland complex named the Haire Wetland and the former 2-acre Walter Wetland. Approximately 1,600 ft of Swan Creek flows through this site. The conceptual plans prepared by the City of Tacoma form the basis for the restoration and enhancement plans described in this document.

In June and July 1999, Pentec Environmental, Inc. (Pentec), completed a fish habitat assessment and a hydrologic evaluation in Swan Creek. Pentec also conducted a reconnaissance-level vegetation investigation to determine the location, extent, and character of vegetation communities in the Haire Wetland and riparian zone of Swan Creek. These studies were carried out to assess the areas of this site where restoration and enhancement was most needed and to provide the baseline data for designing the restoration and enhancement work.

Included in this report are the methods used in, and the results of, the fish habitat, hydrologic, and vegetation studies, and the design description and justification for the restoration work. The monitoring and adaptive management plan and the maintenance plan for the restoration work are included in Appendices A and B, respectively

SITE DESCRIPTION

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 3.0-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.



Map prepared from
USGS 7.5 Minute Quadrangle
Tacoma South, Washington

Pentec ENVIRONMENTAL	Swan Creek, Haire Wetland Restoration Tacoma, Washington for the City of Tacoma	Figure 1 Site vicinity map.

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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. 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. A more detailed description of the existing upland and wetland vegetation on the site is presented in the Vegetation Section, which is within the Field Investigation Section.

FIELD INVESTIGATION

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 3). This section of Swan Creek was divided into four reaches based on habitat type (Figure 3). 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 1). Embeddedness is subjective and is determined visually by estimating the percent of the substrate that is embedded with silt. 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).

Rearing Habitat

The following rearing habitat parameters were rated according to the criteria shown in Table 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

Table 1 Criteria for rating fish habitat quality.

Parameter (source)	Habitat Quality Rating		
	Poor	Fair	Good
Spawning habitat			
Embeddedness (Anonymous 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 (Anonymous 1996)	< 1 pieces/channel width	1 - 2 pieces/ channel width	> 2 pieces/ channel width

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

Habitat Quality Ratings

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

Table 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 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

Channel Types

Reaches 1, 2, and 4 are classified as pool-riffle channels based on the geomorphic classification scheme defined by Montgomery and Buffington (1993), and Reach 3 is classified as a regime channel under this classification scheme. Reach 3 has sand as its dominant substrate and the flow through this area is very slow.

Spawning Habitat Quality

Gravel embeddedness is greater than 30 percent in over 60 percent of the available spawning sites in Reaches 1, 3, and 4 (Table 2). The high levels of embeddedness resulted in poor spawning habitat ratings for these three reaches (Tables 1 and 3). Fifty percent of the spawning habitat in Reach 2 is embedded greater than 30 percent and 50 percent of the spawning habitat is embedded less than 30 percent; therefore, this reach is rated fair for spawning habitat, although the quantity of habitat in this reach is very low. Available spawning habitat exists in only two locations.

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.

Overall Habitat Quality

The pool-riffle channel type of Reach 1 should provide 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 salmon (*Oncorhynchus kisutch*) and possibly cutthroat trout (*O clarki*). 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 1979)

- National Wetlands Inventory, Puyallup, Washington, Quadrangle (US Fish and Wildlife Service [USFWS] 1988US Department of Interior 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 3). 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 balsamifera* ssp. *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 the constructed channel or left in upland areas. 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-ft^2 smokehouse, an approximately 120-ft^2 gray shack, and an approximately 1,500-ft^2 white shack. In addition, an approximately 400-ft^2 debris pile consisting of wood, concrete, and some kitchen appliances lies in an open area just north of the white shack. The smokehouse is offsite.

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 3). 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% 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.

ENHANCEMENT AND RESTORATION PLAN

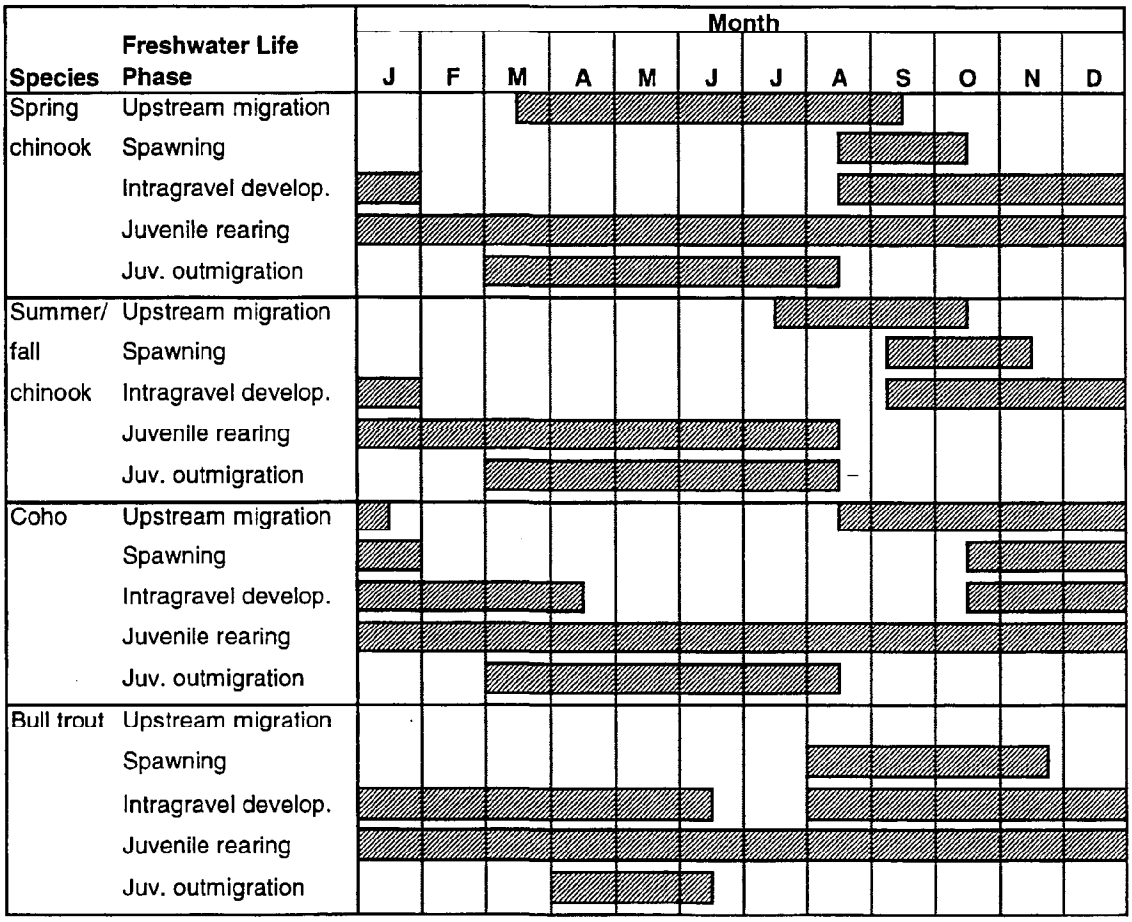
FISH HABITAT

Coho salmon and steelhead (*O. mykiss*) and cutthroat trout are the anadromous salmonid species found in Swan Creek (WDFW and WWTIT 1994, Williams et al. 1975). The timing and life history phases of each of these species are shown in Figure 4. These three species 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 cuthroat 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.

Figure 4 Puyallup River salmonid life history stages.



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

- Increase public awareness of the importance of diverse salmonid habitat in stream systems by providing stewardship and educational opportunities for city and county residents.

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 4 details criteria necessary to achieve a functional channel for spawning and rearing.

Table 4 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 Appendix C 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 (vertical datum is 1929 NGVD) 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 3.0H:1V (see Appendix C, 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 (Table 5). The total length of Channel B is 43 ft, with a watershed length of 35 ft, thereby achieving a sinuosity of 1.22 (Table 5). Instream structures and habitat will be placed as described in the subsequent section.

Table 5 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 six deflector log structures, five logjam structures, six rootwads, and ten large boulders (see Appendix C, Sheet 8 [1 and 3] and Sheet 9 [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 5). 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 Appendix C, 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 Appendix C, Sheet 4 [A]). It must be noted that the elevations provided in Table 5 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 Appendix C, 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 Appendix C, Sheet 3 and 8 [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 Appendix C, Sheet 8 [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 Appendix C,

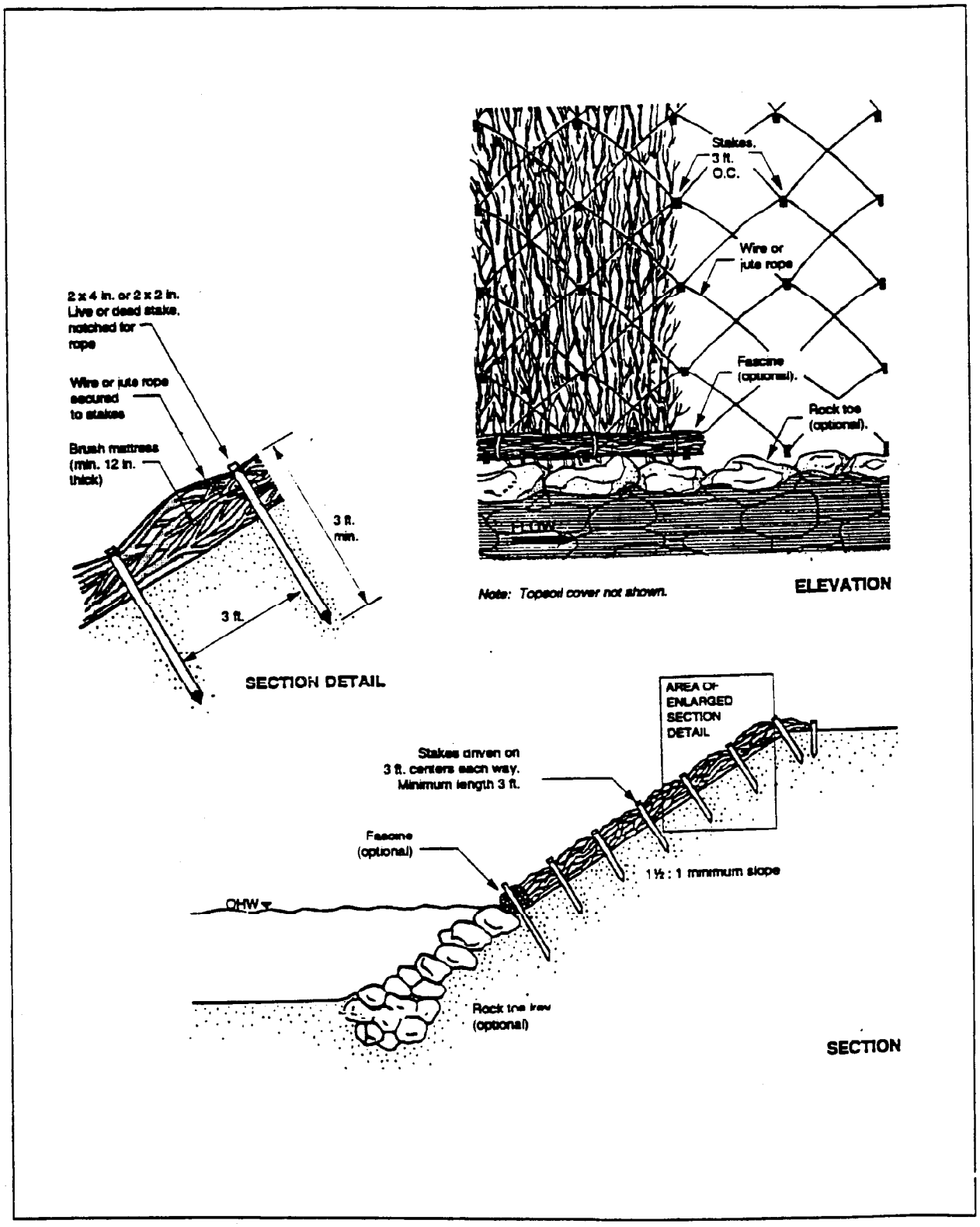


Figure 5 Installation of a brush mattress shown with an optional fascine and rock toe. (Adapted from Gray and Leiser 1982.) (From Johnson and Stypula 1993.)

Sheet 4 [D]). 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.

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 Appendix C, Sheet 8 [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 Appendix CB, Sheet 9 [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 planting zones 2, 3, 4, 5, and 6. 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 consulting biologist or mitigation specialist to ensure that not more than one-fifth of the stems for any plant are taken and donor plants are not adversely affected. 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 (Appendix C, Sheet 6 and 7 and Appendix D) 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. Others were selected as species that naturally occur in native plant communities characteristic of the Puget Lowland region.

Planting Density

Spacing of trees and shrubs varies depending on planting location, vegetation zone, plant type (tree or shrub), and growth habit. Higher planting densities will be used in Zones 1, 2, and 3, which are expected to be cleared of most existing vegetation to construct the proposed off-channel habitat. Lowest densities are specified for dense, second-growth, deciduous, upland forest communities (Zones 4, 5, and portions of 6). See the typical planting details and plant schedules (Appendix C, Sheets 6 and 7 and Appendix D) 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 City's consulting biologist or mitigation specialist based on whether or not the soils meet the proposed soil specification. 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 City's 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 in Appendix D).

In the new channel and reforestation areas, it may be possible to salvage some of the existing fill for use as topsoil. The City's consulting biologist or mitigation specialist will evaluate the suitability of use of fill material for topsoil during clearing and excavation. At that time, detailed evaluation of soil texture and other physical and biological characteristics of existing fill its potential use can be determined. Based on evaluation of fill material characteristics, it may be necessary to amend the existing fill material with topsoil, compost, or a mixture of the two to create a suitable medium for successful establishment of proposed plantings. Under no circumstances shall the retained or amended fill material contain large clods, rocks, litter or construction debris after it has been placed, and final grade completed. All large clods, rocks, litter, and construction debris shall be removed and disposed of off site by the contractor.

Clearing, grading, and any soil amendments of the offchannel and wetland enhancement areas (Zones 1, 2 and 7) 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, respectively. This material shall be layered and placed around each plant so that a shallow well is created and no mulch touches the stem of the plant. This will prevent root crown and stem rot that may occur when mulch material is in direct contact with the stem. Mulch will also improve soil moisture retention capacity and help control establishment or regrowth of invasive species.

Trees and shrubs in all proposed planting zones will be planted as indicated in planting details. If necessary, based on the determination of the City's consulting biologist or mitigation specialist, soil in which trees and shrubs will be planted shall be amended as specified. At a minimum, the soil to a depth of 4 to 6 inches below the rootball of the bare-root, container-stock, and rooted-cutting plantings will be scarified and loosened.

Unless otherwise specified by the City's consulting biologist or mitigation specialist at the time of plant installation, fertilizer use in the offchannel and wetland enhancement areas in

Zones 1, 2, and 7 shall be avoided to prevent potential eutrophication problems in Swan Creek and the Puyallup River. In the upland areas (Zones 3, 4, 5, and 6) potential fertilizer use, such as tablets or time release granules may be used based on the recommendation of the City's consulting biologist or mitigation specialist as determined during plant installation. In all cases, any such fertilizer use will conform to the manufacturer's directions and specifications. Under no circumstances will fertilizer be broadcast onto the soil surface in any of the habitat restoration areas.

Non-Native and Invasive Plant Species Control

Non-native and invasive species, including Himalayan blackberry and reed canarygrass, will be removed by hand or a combination of hand-removal and spot herbicide application. If herbicides are used, only a glyphosate-based herbicide approved for use in aquatic environments by the Washington State Department of Ecology will be used and only in accordance with all applicable manufacturer specifications and with proper approvals. Wherever possible, hand-shoveling will be used, to remove above- and below-ground portions of non-native and invasive plants, especially for rhizomatous species like reed canarygrass and Himalayan blackberry. This method more effectively suppresses re-establishment or regrowth by removing rhizomes that otherwise will resprout to form new above-ground biomass. Non-native plants, including roots, rhizomes, and attached soil, shall be disposed of off-site at a licensed sanitary landfill or composting facility. Native trees and shrubs will be planted where non-native and invasive species have been removed. Establishment of native trees and shrubs will help to further prevent the re-establishment of non-native species. English ivy shall be removed or the stems cut on any of the black cottonwoods that are saved.

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 in Appendix C, Sheets 6 and 7. 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 (Appendix C, Sheets 6 and 7).

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, the constructed channel, or other communities on the site.

Zones 1, 2, 3, 4 and 6 are located upslope of the constructed channel in adjacent uplands. Shrubs, arborescent shrubs, and trees will be planted in these zones, including Pacific ninebark (*Physocarpus capitatus*), Pacific willow, Western crabapple (*Malus fusca*), Oregon ash (*Fraxinus latifolia*), black cottonwood, Sitka spruce (*Picea sitchensis*) and western red cedar (*Thuja plicata*). Pacific willow, Pacific ninebark, and Oregon ash will be planted in wetter areas along the constructed channel in Zones 1 and 2, which are expected to remain relatively moist as a result of capillary action. A three-tiered structure will be created as follows: shrubs will generally be placed in Zone 1 near the toe of the slope. Deciduous trees, including Oregon ash and Pacific willow will be planted at and near the border of Zones 1 and 2 as shown in the planting detail and typical section. Cottonwood and conifers will be planted in upslope areas in Zones 2, 3, and 4 to provide shading and bank stability (see planting detail for Communities A, C, and D and these zones). 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 (1 and 2)—As shown in Appendix C, Sheet 5, the channel will be constructed to connect Swan Creek and the Haire Wetland. Two planting zones will be established in the constructed channel (Zone 1 and Zone 2). Zone 1 will extend from the OHWM upslope to about midbank. Zone 2 will extend from near the middle of the streambank to the top of bank as shown in the planting detail and typical section for Zones 1 and 2. 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 1, 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 2 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. Trees in Zone 2 will provide a future potential source of LWD to the channel.

South of the Constructed Channel—An approximately 1-acre upland area (Zone 6) will be converted from primarily driveways, existing deciduous forest, and invasive species to a mixed deciduous and evergreen riparian forest. It is assumed that about one-third of this area will be totally cleared and may be used to stockpile construction materials and equipment and as a staging area for constructing the new channel, and about two-thirds of this area will remain covered by the existing deciduous forest of black cottonwood. 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 much of the area south of the new channel 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. Douglas fir, western red cedar, big-leaf maple, and western hemlock will be used in the more open areas now occupied by buildings, meadow vegetation, and driveways. Areas in between trees will be planted with a mixture of hazelnut (*Corylus cornuta*), salal (*Gaultheria shallon*), and oceanspray (*Holodiscus discolor*) as shown in the typical sun planting detail for this area. A more shade-tolerant community will be created beneath the existing black cottonwood canopy. Shade-tolerant trees, including western red cedar, western hemlock, madrone (*Arbutus menziesii*), and big-leaf maple, will be planted beneath the cottonwood canopy. In addition, a mixture of evergreen huckleberry (*Vaccinium ovatum*), salal, vine maple, and swordfern

(*Polystichum munitum*)will be planted around and in between groups of evergreen trees as shown in the typical shade 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.

Zone 3 (Public Access Zone)—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 newly constructed channel and 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 3). 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 (Zone 7) as well as in the Constructed Stream Channel (Zones 1 and 2).

Although no plantings will be done in this community, large logs or stumps with rootwads attached may be placed in selected locations. Black cottonwoods and other trees cleared to constructed the public access and constructed channel may be salvaged and placed in the Haire Wetland or used for LWD in the constructed channel. Logs will be installed by either mechanized equipment through areas in either Communities C or D cleared of invasive species (e.g., Himalayan blackberry), or possibly lowered in by helicopter. In no circumstances will access roads to the wetland be constructed so that track hoes or other equipment can place logs in the wetland. 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 3, 4, 5, and 6 within Communities A, 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 Figure 2). 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 Appendix D, Plant Materials Schedule). 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 1, 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 container stock as shown in the typical planting detail for Zone 7. 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 ft² 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 6.

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.

Table 6 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)	10	Each
Logs for log weirs (9-ft length x 16-18-inch diameter)	6	Each
Logs for log sill, deflector log and channel constrictor structures (10- to 20-ft length x 12- to 18-inch diameter)	30	Each
Logs for log jam and deflector log structures (5-ft length x 10- to 12-inch diameter)	16	Each
Logs for log jam and deflector log structures (3-ft length x 10-to12-inch diameter)	10	Each
Rootwads 6-ft length x 12- to 18-inch diameter	6	Each
Jute matting	11,460	Ft^2
Hydroseed	0.50	Acres
Live stakes	100	Each

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.

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Appendix A—
Monitoring and Adaptive Management Plan

APPENDIX A
MONITORING AND ADAPTIVE MANAGEMENT PLAN

INTRODUCTION

This monitoring and adaptive management plan has been developed to monitor and ensure the success of the Swan Creek and Haire Wetland Restoration project. The plan is composed of two major elements: monitoring and adaptive management. For the first element, the plan includes qualitative and quantitative sampling methods that will be used to monitor and measure the ecological success of the project. Qualitative monitoring measures will include evaluation of the health and vigor of planted and naturally colonizing species, placement and function of large woody debris structures (LWD), and establishment of permanent photo points. Quantitative monitoring measures for the vegetated areas will include long-term, random sampling of vegetation and sediment along transects traversing the different enhancement areas in Communities A, C, D, F, and G. This monitoring data will be compared to establish performance standards (goals and objectives) for plant cover, species composition, and diversity to evaluate ecological success. Quantitative monitoring measures for the fish habitat created will include an assessment of the fish habitat created. Additionally, each LWD structure will be evaluated to determine if it is functioning as intended.

The adaptive management portion of the plan is an interactive decision-making, feedback loop that specifies contingency measures or corrective actions to be implemented if monitoring data suggest the restoration may not meet performance standards. Contingency measures may include modification of the physical configuration of the site, supplemental plantings, modification of LWD structures, addition of LWD structures or pieces, substrate amendments, and/or modification of project goals and objectives.

PERFORMANCE STANDARDS (GOALS AND OBJECTIVES)

The overall objectives of the project are as follows:

- Create side-channel rearing habitat for juvenile salmonids and other aquatic biota and amphibians.
- Create potential spawning habitat in a 530-ft channel connecting Swan Creek to the Haire Wetland.
- Restore and enhance the areal extent and associated functions of the Haire Wetland, Swan Creek, and associated riparian and upland forest habitats that have been greatly diminished or lost since the beginning of the industrial revolution.

Because aquatic environments are dynamic, restoring them is a challenge and requires application of an adaptive management strategy. Performance standards for areal coverage of native and invasive plants in each vegetation zone have been established to evaluate whether these goals and objectives are being met during the monitoring period. Performance standards for fish habitat created are based on habitat requirements of salmonids reported in the literature. In the event that standards for vegetation cover, species diversity or fish habitat are not being met, appropriate contingency measures will be implemented as part of the adaptive management process. The intent of this process is to use monitoring data and professional judgment to make appropriate decisions that will reasonably ensure the long-term success of the project.

MONITORING METHODS

A combination of qualitative and quantitative monitoring methods will be employed to measure the ecological success of the proposed restoration. Qualified professionals will implement all monitoring methods. Proposed monitoring methods may be changed in the future as part of the adaptive management process. Before implementing any proposed changes, they will be discussed with and agreed to by the Natural Resource Trustees and the City of Tacoma,.

Following adoption of any such changes through mutual consent, they will be carefully documented in subsequent monitoring reports.

QUALITATIVE METHODS

Vegetation

Professionals conducting this monitoring will make a number of qualitative observations on vegetation and wildlife as they collect quantitative data. To ensure the same observations are made each year of monitoring, the data form shown in Tables A-1 and A-2 will be used. Qualitative data will be collected within each enhancement and restoration area on plant cover, density, height, and survival; erosion and sedimentation; organic matter accumulation (e.g., leaf litter); naturally colonizing plants; and large organic debris. In addition, observations of wildlife use, including avifauna, amphibians, reptiles, small mammals, fish, and macroinvertebrates, will be recorded during each monitoring event.

To supplement these qualitative data, up to 10 permanent photo points will be established as shown in Figure A-1. Photo points will be established to coincide with different enhancement zones and be located at topographic vantage points that afford the most complete views of the different enhancement and restoration zones. Photos will be taken looking in the directions shown at each photo point. These will document relative changes in plant cover, density, and height, as well as changes in topography resulting from erosion and sedimentation processes. Permanent markers will be established at each photo point (either PVC, wood lathe, or a combination of PVC and rebar).

QUANTITATIVE METHODS

Vegetation

A stratified random sampling design will use transects and quadrats to monitor plant cover, survival of transplanted native plants, natural colonization, and successional patterns of native and invasive plant species. Six transects will be established within the different vegetation zones (Figure A-1).

Along each transect, between 5 and 10 sample plots (i.e., quadrats) will be established to measure the cover and distribution of native, non-native, and invasive plants. To eliminate potential bias, sample plot locations will be established using a random-number generator. Quadrat sample size will vary between the different enhancement and restoration zones to reflect the patch size and variation of vegetation communities and different life forms of plants within these areas. For shrubs, quadrat size will be at least 7 m^2 (3-m-diameter circular plot) and trees 64 m^2 (9-m-diameter circular plot)

Table A-1 SWAN CREEK RESTORATION VEGETATION SAMPLING

DATE: _____ LOCATION: _____ TRANSECT: _____

WEATHER: _____ PHOTOS: _____

QUAD NO.	1	2	3	4	5	6	7	8	9	10
Random Meter No.										

TAXA	% Plant Cover per 7m² (shrubs) and 29 m² (trees)									
Trees:										
Abies grandis										
Acer macrophyllum										
Alnus rubra										
Arbutus menziesii										
Cornus nuttallii										
Fraxinus latifolia										
Picea sitchensis										
Populus balsamifera ssp. trichocarpa										
Prunus emarginata										
Pseudotsuga menziesii										
Salix lucida ssp. lasiandra										
Thuja plicata										
Tsuga heterophylla										
Shrubs:										
Acer circinatum										
Cornus sericea										
Corylus cornuta										
Crataegus douglasii										
Gaultheria shallon										
Holodiscus discolor										
Lonicera involucrata										
Mahonia aquifolium										

Notes:

Table A-1 SWAN CREEK RESTORATION VEGETATION SAMPLING

DATE: _____ LOCATION: _____ TRANSECT: _____

WEATHER: _____ PHOTOS: _____

QUAD NO.	1	2	3	4	5	6	7	8	9	10
Random Meter No.										

TAXA	% Plant Cover per 7m² (shrubs) and 29 m² (trees)									
Shrubs (continued):										
Malus fusca										
Physocarpus capitatus										
Ribes sanguineum										
Rosa nutkana										
Salix hookeriana										
Salix scouleriana										
Salix sitchensis										
Sambucus racemosa										
Symphoricarpos albus										
Vaccinium ovatum										
Herbs:										
Polystichum munitum										

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Notes:

Table A-2

Line Intercept Method Data Form

Site: Swan Creek Restoration

Investigator: _____

Transect:

Date: _____

Transect Length:

	Plant Species												Plant Survival			
Plant Number	Intercept (ft.)	dbh (in.)	ht. (ft.)	Intercept (ft.)	dbh (in.)	ht (ft.)	Intercept (ft.)	dbh (in.)	ht. (ft.)	Intercept (ft.)	dbh (in.)	ht. (ft.)	Int. Loc'n	Species	L or D	ht. (ft.)
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
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25																
26																
27																
28																
29																
30																
Total Int. Length																
% Cover																

Table A-2 (continued).

Line Intercept Method Data Form

Notes: Int. = the length of the transect intercepted by each plant in feet; it is measured by drawing an imaginary line from the edge of the plant canopy to the tape measure (e.g., 62 - 65 = 3 ft.)
dbh = estimated diameter at breast height; for shrubs with multiple stems cite a range.
ht. = estimated height of each tree or shrub
Plant Survival is measured within a belt transect that extends one meter to the east and west of the line intercept transect; it is calculated by adding the total number of living plants (L) and dead plants (D) together (including those in the intercept column for each species)
Int. Loc'n = the location of each species within the belt transect is recorded, including the intercept point and side of the transect (E for east and W for west) for each plant.

Herbaceous plant communities will be sampled with a circular, 1.5-m-diameter quadrat. Quadrats will be divided into subsections of known percent area to aid in estimation of percent cover. Trees and shrubs within the different zones will be sampled with circular, quadrats as noted above. In addition, line intercept methods (Barbour et al. 1980) will be used to estimate cover of trees and shrubs along each transect. Along each transect, the line-intercept method will be used to measure the cover of trees and shrubs within the different planting zones. The percent cover of each tree and shrub species is measured by extending a fiber-glass tape measure between the permanent transect endpoints of each transect, which will be marked with rebar and PVC pipe or other permanent markers. Percent cover for each species is the total amount of linear area of the tape intercepted by tree or shrub foliage divided by the total length of the transect. In addition to measuring cover for each species, total percent cover also will be calculated. Total percent cover is the sum of all individual species cover data for the entire transect. The total percent cover of all native species (trees, shrubs, and herbs) will be used to evaluate the performance standard for cover of native species.

Once sampling locations have been determined, the percent cover of each plant species present within each quadrat will be visually estimated along with the percent of bare ground (all viewed from the vertical). Individual species' cover values will be summed to determine the total areal coverage in each quadrat. Daubenmire cover classes (0-5%, 5-15%, 15-25%, 25-50%, 50-75%, 75-95%, and 95-100%) and cover class midpoint values (2.5%, 12.5%, 35%, 65%, 85%, and 97.5%) for each species also will be recorded. Average total areal cover for all quadrats within each zone will be calculated using the estimated cover and cover class midpoint values. To ensure that the same locations are monitored each year and to minimize bias and sampler error, transects and sample plot locations will be clearly marked with PVC or wood lathe. A map of the vegetation zones, transects, sampling locations, and property boundaries will be created in AutoCAD®.

Fish Habitat

Professionals conducting this monitoring will assess fish habitat along the entire length of each of the three newly constructed channels. Fish habitat will also be assessed along the 100-ft reach of Swan Creek where bioengineered structures will be placed. Fish habitat conditions will be determined using the same methods described in the Field Investigation Fish Habitat Methods section of the design report, which is a habitat unit survey method similar to that described by

Hankin and Reeves (1988). The location of any barriers that could prevent movement of adult or juvenile salmonids will also be identified during the survey. The following habitat elements will be examined: number of spawning sites, 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). Tables A-3 and A-4 will be used to record the fish habitat assessment data.

Hydraulic performance of the 6 weirs will also be assessed during monitoring to ensure that they are functioning as designed. The amount of water flowing through Swan Creek will be assessed as well as the height of the weir to ensure they are not fish barriers. Adjustments in weir height will be made as needed.

Stream channel type, as defined by Montgomery and Buffington (1993), includes the following: pool-riffle, forced pool-riffle, plane-bed, step-pool, braided, and regime will be assessed for each of the newly created channels.

DURATION, FREQUENCY, AND TIMING

Monitoring of as-built conditions will be conducted in Year 0. Subsequently, monitoring will be conducted annually in Years 1, 2, and 5. Based on this proposed schedule of monitoring, a total of four monitoring events would be conducted over a 5-year period. Monitoring will be conducted in mid- to-late summer (late in the growing season), when vegetation is more or less fully developed for the current growing season and fish eggs have hatched. This schedule is expected to provide the most meaningful comparison for evaluating changes in the distribution and extent of plants in both time and space. Following the monitoring event after the fifth year, the City of Tacoma and the Natural Resource Trustees will meet to evaluate the monitoring data and will discuss the need and resources available for further management.

REPORTING

Reports documenting monitoring results will be completed within 6 weeks of each monitoring event. Copies of each report will be submitted to the Natural Resource Trustees. If necessary, follow-up meetings will be held between the City and the Natural Resource Trustees to discuss the monitoring results and any adaptive management recommendations included in the reports.

Table A-3 Fish Habitat Conditions - Field Inventory Sheet for Watershed Analysis

Stream _____ **Date** _____ **Crew** _____
Segment No./Location _____
Gradient _____ **Bankful Width** _____ **Wetted width** _____ **Channel Morphology** _____
Confinement _____ **Water Temperature** _____ **Time** _____ **Flow** _____

ENDING DIST, (Meters)	HAB. TYPE Pool Riffle Cascade	---POOLS ONLY---						HAB FORM	SUBSTRATE Sand, Gravel, Cobble, Bolder		
		RESDP (cm)					% Wood Cover	W - Wood B - Boulder R-Rootwad	DOM	SDOM	SPGRV > 30% Emb. Y/N
		0 - 15	15 - 30	30 - 60	60 - 100	> 100					

Describe Conditions for: Off-Channel Rearing, Holding Pools, Redd Scour Potential, and Migrant Access Problems

Table A-4 Stream Survey **Large Woody Debris Inventory**

Stream Name_____ **Date** _____ **Recorder** _____
Stream Code _____ **Reach No.** _____ **Page**_____

Segment		Zone	Tally by log diameter group			No. in decay class		No. by recruit process		Function	
Start	End		10 - 30 cm	30 - 60 cm	> 60 cm	green	twigs	rootwad	blowdown	dom	sdom

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ADAPTIVE MANAGEMENT PLAN

Ecological success of the project will be measured and evaluated based on monitoring and performance standards established by the Adaptive Management Team, which consists of the Natural Resource Trustees, the City of Tacoma, and qualified professionals selected to monitor the project. Following each monitoring event, the Adaptive Management Team will discuss the monitoring data and any recommended contingency measures identified by the monitoring team, and strategies for implementing appropriate contingency measures. Implementation of this adaptive management process will be an essential element to project success.

PERFORMANCE STANDARDS

Vegetation

Plant Cover, Survival, and Invasive Species

Specific and general performance standards will be used to evaluate the successful establishment of the constructed channel, riparian, and upland forest habitats. Specific performance standards will include total areal cover and percent survival of plantings. Average percent cover will be used to evaluate differences between different years of monitoring. Because much of the energy during the first few years of growth is spent on root development, and unusual or unexpected environmental fluctuations can be detrimental to the successful establishment and survival of transplants, the performance standards for the first 2 years should be relatively modest; measurable gains should be expected by the fifth year. Total areal cover of invasive species, particularly reed canarygrass, Himalayan blackberry, and Scot's broom, are other metrics of ecological success.

Specific Performance Standards

Specific performance standards for total areal percent cover of native plants, percent survival of installed plant materials, and total area percent cover of invasive species for each of the enhancement and restoration areas are identified in Tables A-5 through A-8.

Table A-5 Performance standards for Community A enhancement areas (Zones 1, 2, 3, and 6).

Criterion	Year 0	Year 1	Year 2	Year 5
Total areal cover of native plants (%)	10-20	20-30	30-40	60-80
Survival of installed plants (%)	80	80	80	80
Total areal cover of invasive species (%)	0-5	5-15	5-15	5-10

Table A-6 Performance standards for reforestation areas in Communities C and D (Zones 4 and 5).

Criterion	Year 0	Year 1	Year 2	Year 5
Total areal cover of native plants (%)	30-45	30-50	35-60	60-85
Survival of installed plants (%)	80	80	80	80
Total areal cover of invasive species (%)	0-5	5-15	5-15	5-10

Table A-7 Performance standards for reed canarygrass control areas in Communities E and G (Zone 7).

Criterion	Year 0	Year 1	Year 2	Year 5
Total areal cover of native plants (%)	10-20[a]	20-30	30-40	60-80
Survival of installed plants (%)	80	80	80	80
Total areal cover of invasive species (%)	0-5	5-25	5-25	5-15

a Cover criterion assumes that plantings will be installed in the spring and cover estimated in the late summer of Year 0.

General Performance Standards

In addition to the specific performance standards, there are general performance standards for total area percent cover of native and invasive plants, as noted below.

Average Total Percent Areal Cover of Native Plants

- Year 0 – Average total areal cover of native or naturalized non-native plants for all of the enhancement areas (Communities A, C, D, E, and G), based on line intercept and quadrat data, shall be between 20 and 40 percent, which is equivalent to between 1.4 and 2.8 acres.

- Year 1 – Average total areal cover of native or naturalized non-native plants shall be for all of the enhancement areas (Communities A, C, D, E, and G) based on line intercept and quadrat data, shall be between 25 and 50 percent, which is equivalent to between about 1.8 and 3.5 acres.

- Year 5 – Total areal cover of native or naturalized non-native plants for all of the enhancement areas (Communities A, C, D, E, and G), based on line intercept and quadrat data, shall be greater than 60 percent, which is equivalent to more than about 4.2 acres.

Average Total Percent Areal Cover of Invasive Plants

Areal coverage and extent of non-native or invasive species, which are undesirable, is another way to evaluate the success of the project. As native vegetation matures, it is generally expected to outcompete or prevent the establishment of undesirable species. So, following relatively high values for the first 2 years because of the presence of invasive species, the presence of undesirable species should be declining or at least not increasing rapidly by Year 5.

- Year 0 – Average total areal cover of invasive plants for all of the enhancement areas (Communities A, C, D, E, and G), based on line intercept and quadrat data, shall be between 0 and 15 percent, which is equivalent to between 0 to 1.1 acres.

- Year 1 – Average total areal cover of invasive plants for all of the enhancement areas (Communities A, C, D, E, and G), based on line intercept and quadrat data, shall be between 0 and 20 percent, which is equivalent to between about 0 and 1.4 acres.

- Year 5 – Total areal cover of invasive plants for all of the enhancement areas (Communities A, C, D, E, and G) based on line intercept and quadrat data, shall be less than or equal to 15 percent, which is equivalent to no more than about 1.1 acres.

Diversity

Species diversity is another measure of evaluating the ecological success of the project. The long-term goal for species diversity within the created habitats is to have comparable diversity to intact or reference areas in the vicinity. Many riparian plants may recolonize the site as a result of animal and wind dispersal of seeds. The diversity values provided are targets only and not criteria by which success or failure will be judged.

- Year 1 – At least 35 species of native shrubs and trees shall be present and abundant; species will be considered abundant if they occur in 50 to 60 percent of the quadrats.
- Year 2 – Between 35 and 45 species of native or naturalized non-native herbs, shrubs, and trees shall be present and abundant (as defined under Year 1).
- Year 5 – Between 40 and 50 species of native or naturalized non-native herbs, shrubs, and trees shall be present and abundant (as defined under Year 1).

Fish Habitat

Performance standards for the fish habitat created will be based on criteria set forth by Raleigh et al 1984 and Anonymous 1996) shown in Table A-8.

Table A-8 Criteria for rating fish habitat quality.

Parameter (source)	Habitat Quality Rating		
	Poor	Fair	Good
Spawning habitat			
Embeddedness (Anonymous 1996)	> 60 percent of sites with embeddedness > 30 percent	> 60 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 (Anonymous 1996)	< 1 pieces/channel width	1 - 2 pieces/ channel width	> 2 pieces/ channel width

Performance standards for the weirs will be based on the water levels in Swan Creek, in Channels A and B, and in the Haire Wetland.

CONTINGENCY MEASURES

If identified performance standards are not met at any time, the nonconformance will be identified and described in the monitoring report. In addition, recommended contingency measures or adaptive management actions will be developed by the Adaptive Management Team to increase the long-term probability that successful habitat restoration will be achieved. These recommended strategies will be communicated to the Adaptive Management Team for discussion and approval.

Plant Cover and Species Diversity

A number of factors could influence plant establishment and natural recolonization in the different vegetation zones and result in failure to meet plant cover and species diversity performance standards. Through the process of monitoring the restoration project, knowledge and understanding of site conditions affecting plant survival and growth should increase. As this body of knowledge increases, it may become clear that there are some potentially beneficial or adaptive management strategies or contingencies that may be employed to increase the probability of successfully meeting these standards or accelerating the successful restoration of aquatic habitats on site. These strategies could include some combination of the following actions:

- Control herbivory.
- Supplemental plantings.
- Substitute plants with higher survival rates for those with lower survival rates.
- Amend soil.
- Modify the performance standard or goal.

Invasive Species

Controlling the spread and cover of invasive plants is an important goal. Adaptive management actions that may need to be implemented to achieve effective control may include the following:

- Prevent the spread of invasive species through physical removal.

- Develop an integrated pest management plan to control them.
- Implement control methods.
- Modify the areal coverage goal.

CONCLUSIONS

Habitat restoration is an inexact science. Successful achievement of the restoration goals identified in this plan will require careful construction control and transplanting, vigilant monitoring, and thoughtful consideration of monitoring data in conjunction with project goals. Implementation of an adaptive management strategy is also expected. This strategy includes identification and implementation of contingency measures based on postconstruction monitoring. Using this process, a high probability of success for the proposed habitat restoration and enhancements is expected.

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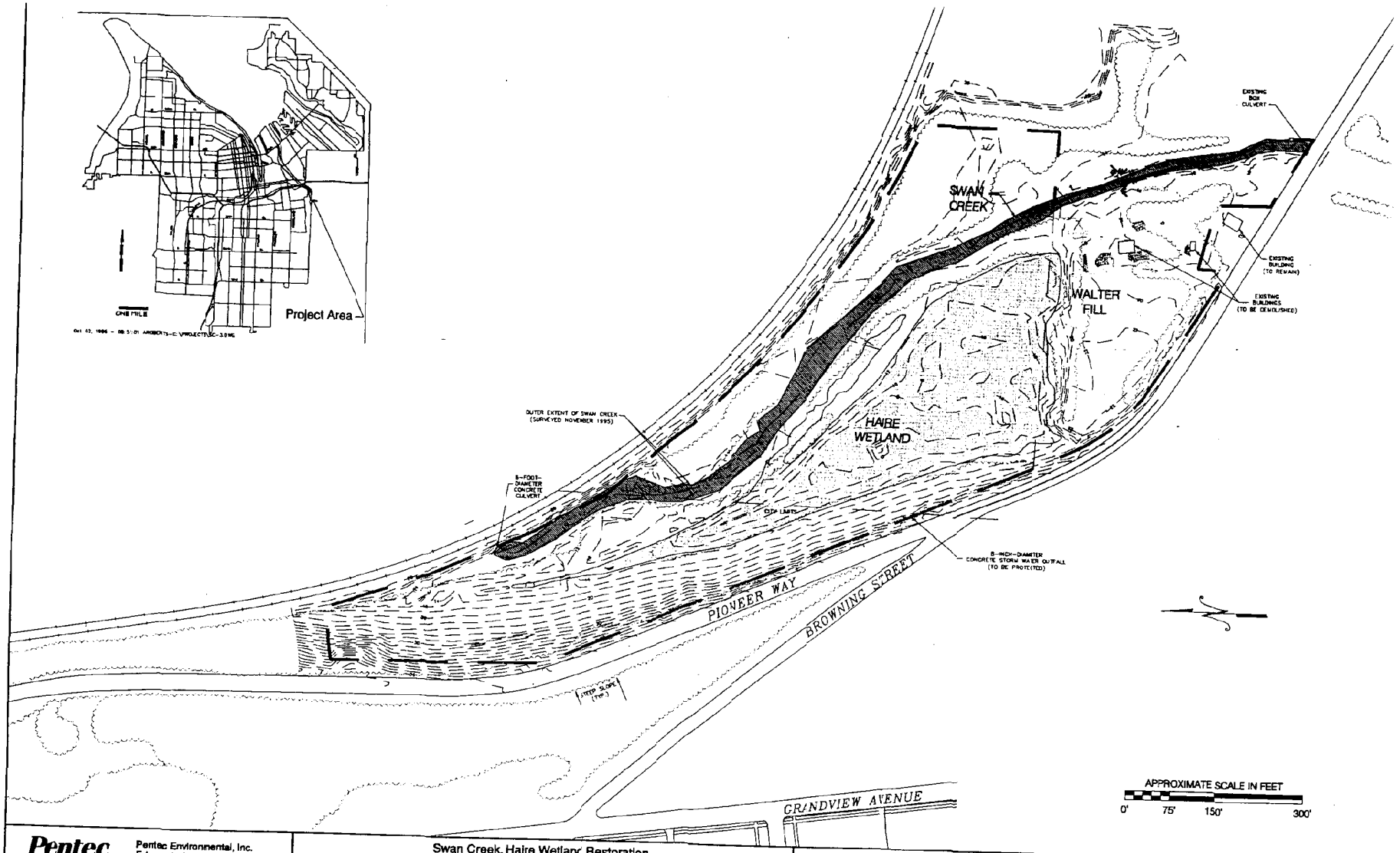

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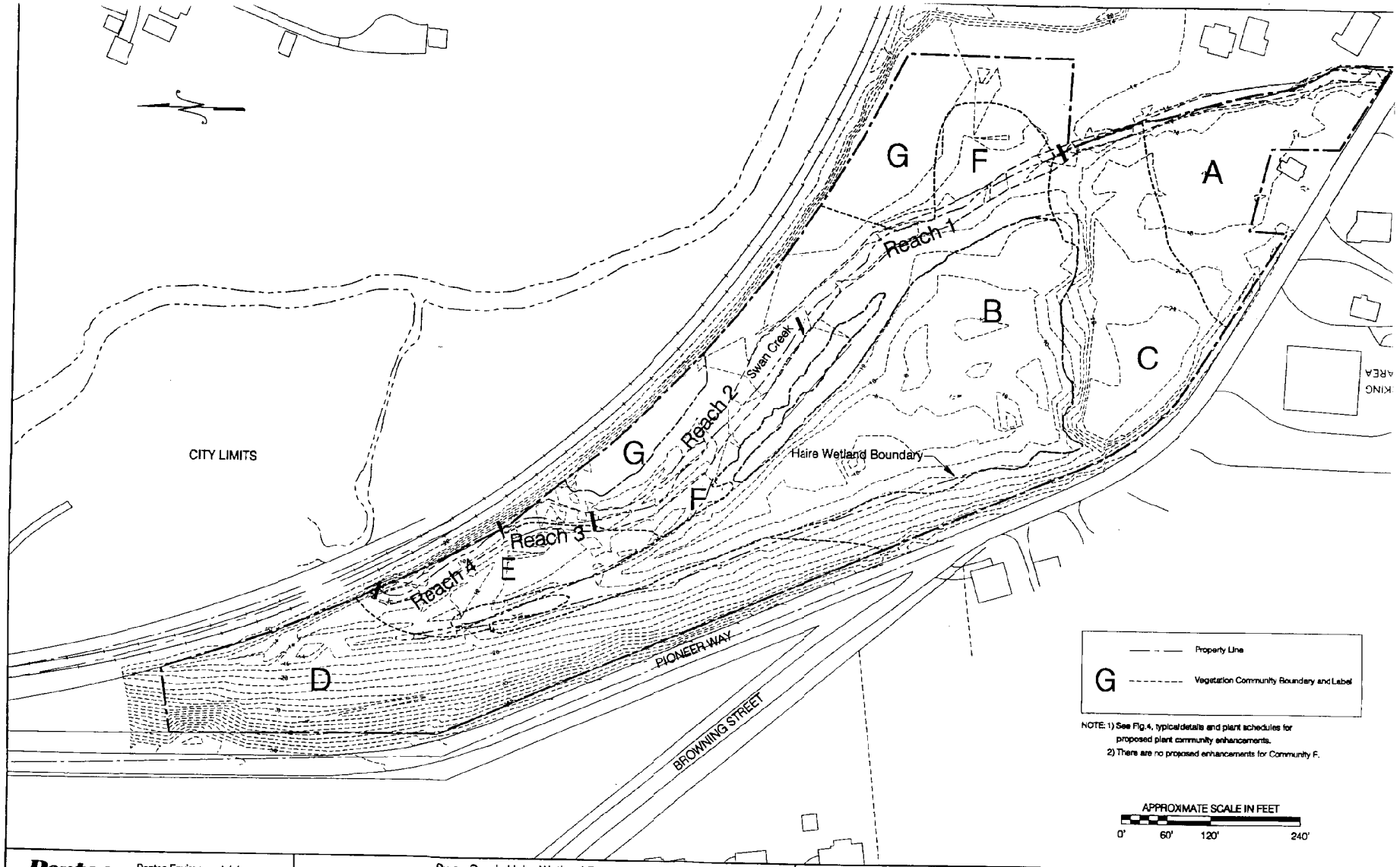
Swan Creek, Haire Wetland Restoration
Tacoma, Washington
for City of Tacoma

Figure 2

Swan Creek existing conditions.



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

Figure 3
Existing plant communities and reach locations.

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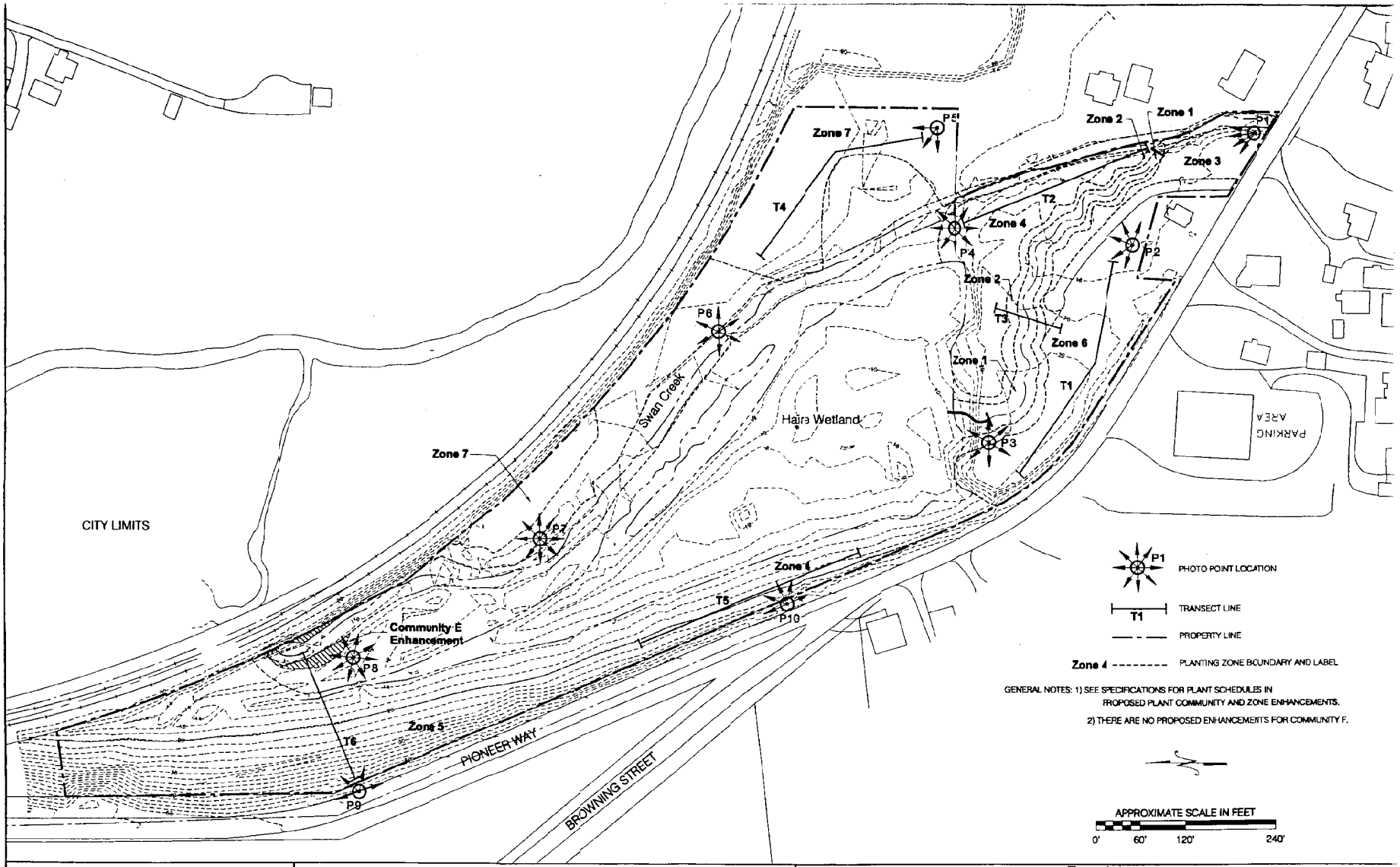

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Tacoma, Washington
for City of Tacoma

Figure A-1
Proposed monitoring locations.

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Appendix B—Maintenance Plan

APPENDIX B
MAINTENANCE PLAN

INTRODUCTION

The greatest portion of maintenance will occur during the first 2 years following implementation of the restoration plan; however, maintenance will continue throughout the 5-year monitoring period. These activities will include watering, weeding, litter removal, removal and replacement of dead plants, and inspection and repair of the bioengineered structures and slopes. Additionally, maintenance activities in the restoration areas will be guided by the results of mitigation monitoring and may change throughout the duration of the monitoring and maintenance period in response to adaptive management measures prescribed by the City of Tacoma (City) and the Trustees. Assuming the restoration plan is implemented in the fall of 2000 or early spring of 2001, maintenance will be conducted at least through fall of 2005 or spring of 2006.

PLANTS

Watering

Depending on when native plants are installed, watering will likely be necessary through the summer drought period during the first growing season after installation. Watering will be sufficient to maintain adequate moisture in the root zone to allow successful growth and establishment of plantings. Watering will be required if soils feel dry when a finger is inserted into the soil around the base of plants. It is expected the contractor shall be responsible for watering all plants to ensure survival. Maintenance will require periodic inspection of the irrigation system to ensure proper functioning. A regular bimonthly maintenance schedule is recommended between mid-July and the end of October during the first growing season and possibly during the second growing season. The schedule will depend on whether there is an unusually long summer drought or if unseasonably dry conditions persist, such as more than 2 weeks without more than a trace of precipitation. Following the second complete growing season the temporary irrigation system can be removed. Only plants that are installed to replace dead plants will require watering following the second growing season in 2002. These plants can be watered using buckets or a backpack apparatus.

Weeding

Weeding around plantings will be important during the first and second year following installation to ensure successful establishment, particularly in the portions of planting zones where invasive species have been removed. Portions of planting zones 4, 5, 6, and 7, where reed canarygrass, Himalayan blackberry, English ivy, and Scot's broom have been removed and replaced by native plants, will be particularly important maintenance areas. These invasive species are likely to regrow from incompletely removed roots or from viable seed in the soil and can form dense communities capable of outcompeting native plants. In the first growing season following installation, weeding will occur at least once a month between April and November. A combination of cultural and chemical treatments, such as physical removal of weeds, mulching, and spot treatment of weeds with a glyphosate-based herbicide, will likely be the most successful techniques.

Because of concerns about herbicide toxicity to fish and aquatic life in Swan Creek and the Haire Wetland that may result from drift or overspray, only herbicides approved for use in aquatic environments by the Washington State Department of Ecology (Ecology) will be used (if at all). In addition, herbicides will be applied only according to manufacturer specifications by a licensed applicator and with proper approvals from all applicable agencies, including Ecology.

Weeding will also occur at least once near the beginning (March), middle (June), and end (October) of the growing season the second and third years after installation. More frequent weeding may be required depending on the growth rate of native plants and the rate of regrowth or reintroduction of invasive species. If the planting occurs in the fall of 2000 or spring of 2001, this schedule will be followed through 2003.

Following more intensive weed-removal efforts after the second full growing season, a less frequent weeding schedule should be sufficient to control invasive species. At a minimum, cultural and/or spot herbicide applications will be done in the beginning (March) and end (October) of the growing season the third through the fifth years following implementation of the restoration plan. In other words, weeding will be conducted according to this schedule from 2003 through 2005. More frequent weeding may be required in Zone 7 if reed canarygrass appears to be spreading or continuing to regrow and recolonize areas around plantings rapidly.

Except in areas where invasive species have been removed or aggressively regrown, weeding will be done using simple hand tools, (e.g., rakes, hoes, or machetes). In areas where Himalayan blackberry, reed canarygrass, or English ivy have regrown or recolonized and formed dense patches, mechanical weed-removal methods such as gas-powered weed eaters may be used to control weeds. The contractor and his/her employees will be trained and able to identify native plants to ensure these are not inadvertenly removed during weeding. If native plants are accidentally removed, they will be replaced by the contractor at no cost to the City.

Litter Removal

Litter will be removed from all planting zones. Litter removal will occur at least monthly or according to a mutually agreed upon schedule established by the City and the Trustees. All litter removed from the site will be properly disposed of in a designated landfill or transfer station.

Dead Plant Material Removal

Dead plant material will be removed and replaced as directed following each mitigation monitoring event. This will allow the City and Trustees to evaluate the progress of the restoration and determine if adaptive management measures such as additional plantings are required to meet established performance standards. Removal and replacement of dead plants will be implemented as directed by the City and Trustees.

BIOENGINEERED STRUCTURES

Each bioengineered structure should be inspected bi-annually; once at the beginning and once at the end of each rainy season. The first inspection should take place after the first high flow condition, which usually occurs after a major storm event (1 inch of precipitation in a 24-hour period) or after an extended period of measurable precipitation (a 5-day period with measurable precipitation of > 0.3 inches/day). The second inspection should take place in mid-April to mid-May after consistent measurable precipitation has ceased.

Rootwads, Deflector Logs, Channel Constrictors, Log Jams, Log Sills, and Live Branch Layering

Each rootwad, deflector log, channel constrictor, log jam, and log sill structure should be inspected to see if the structure has moved from its original placement. Each structure should be inspected for any signs of instability. The live branch layering along the slopes of the channel should be examined for signs of erosion. If any of the above conditions are detected, maintenance should be performed as follows:

- Movement of a bioengineered structure: The structure should be moved back to its original place and additional cable and/or rebar should be used to secure the structure.
- Instability of a bioengineered structure: The structure should be secured with additional cable and/or rebar.
- Bank erosion: The cause of the erosion should be evaluated and the appropriate measures taken to stop further erosion from occurring. Repairs to the live branch layering should occur as appropriate (i.e., reinforcing the installation of the geotextile material used in the live branch layering or securing the live cuttings within the banks).

Log Weirs and Concrete Weir

Each log and concrete weir should be inspected to ensure that it is properly functioning and secure within the channel bank. Any signs of instability should be reported to the project engineer and, upon instructions from the engineer, appropriate measures should be taken. Additionally, any debris that has accumulated on the log weir should be removed.

Boulders

Any large debris should be removed from the boulders. The location of the boulders should be inspected and if movement of the boulders has occurred, the project engineer should determine if the boulders need to be moved back to the original location.

Appendix C—Draft Design Drawings

Tacoma

CITY OF TACOMA
DEPARTMENT OF
PUBLIC WORKS

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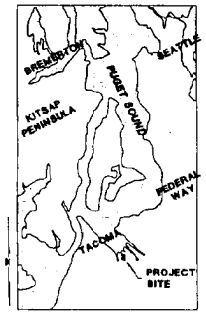
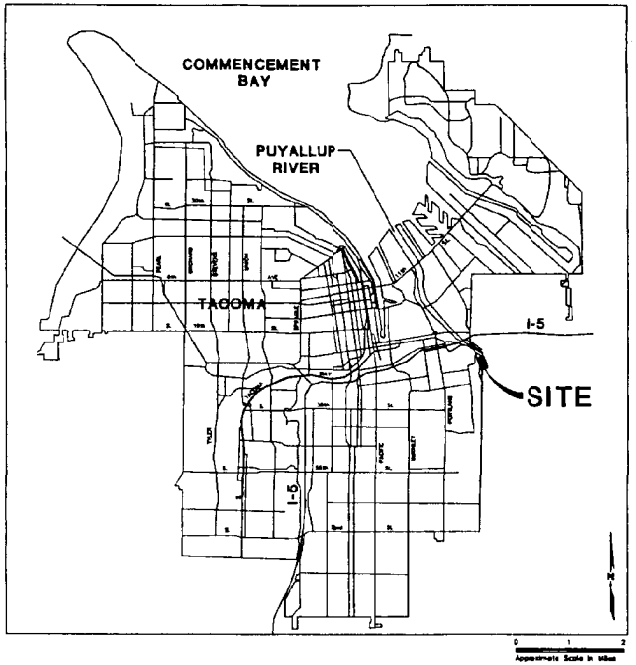


AREA MAP



VICINITY MAP

WORK ORDER DC 1095

SWAN CREEK
STREAM RESTORATION PROJECT

SPECIFICATION NO. G-219-00

FINAL DESIGN

SHEET INDEX

IF SHEET MEASURES LESS THAN 36"x24", IT IS A REDUCED PRINT. REDUCE SCALE ACCORDINGLY.

BENCH MARK:					
PROJ. MGR.:	MPW	DESIGNED BY:	MPW	DRAWN BY:	RZC
CHECKED BY:	CTB	APPROVED BY:	JJW	DATE:	4/12/00
NO.	DATE	BY	REVISION		

UTILITY SERVICES ENGINEERING – DIVISION MANAGER

MICHAEL P. PENTEC — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

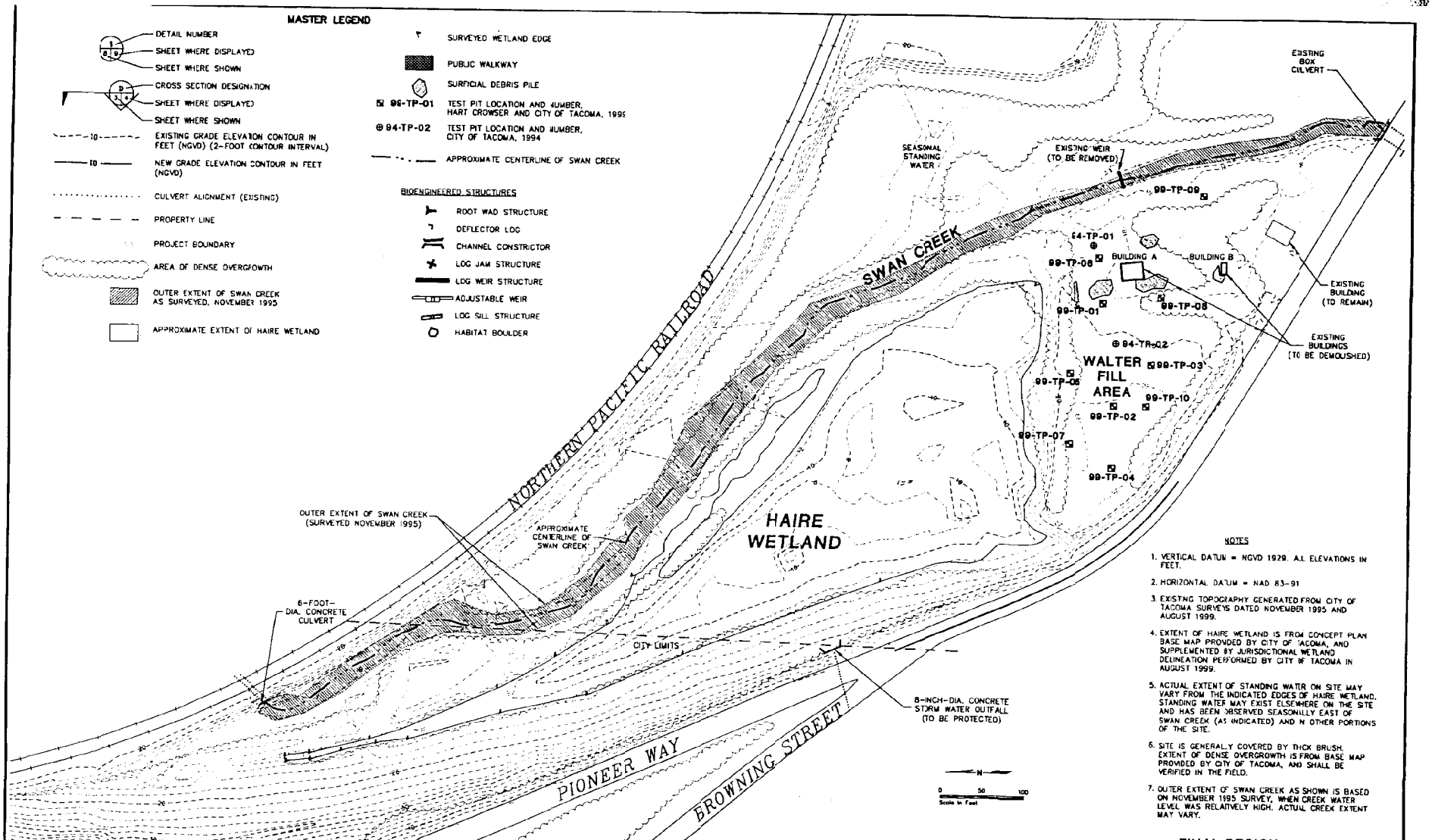
EXPIRES

PENTEC ENVIRONMENTAL
HARTCROWSER
1910 Fairview Avenue East
Seattle, Washington 98102-3699
TEL 206 324 9530 FAX 206 328 5581

FINAL DESIGN
CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

SWAN CREEK
STREAM RESTORATION PROJECT
TITLE SHEET

DRAWING SIZE: 24 x 36 | SCALE: AS SHOWN | DATE ISSUED: 4/12/00 | DRAWING TYPE: | JOB NO.: J-1187 | SHEET: 1 OF 11


MASTER LEGEND
DETAIL NUMBER
SHEET WHERE DISPLAYED
SHEET WHERE SHOWN
CROSS SECTION DESIGNATION
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 HAIRE WETLAND
SURVEYED WETLAND EDGE
PUBLIC WALKWAY
SURFICIAL DEBRIS PILE
99-TP-01 TEST PIT LOCATION AND NUMBER, HART CROWSER AND CITY OF TACOMA, 1999
94-TP-02 TEST PIT LOCATION AND NUMBER, CITY OF TACOMA, 1994
APPROXIMATE CENTERLINE OF SWAN CREEK
BIOENGINEERED STRUCTURES
ROOT WAD STRUCTURE
DEFLECTOR LOG
CHANNEL CONSTRICTOR
LOG JAM STRUCTURE
LOG WEIR STRUCTURE
ADJUSTABLE WEIR
LOG SILL STRUCTURE
HABITAT BOULDER
NORTHERN PACIFIC RAILROAD
SWAN CREEK
HAIRE WETLAND
WALTER FILL AREA
SEASONAL STANDING WATER
EXISTING WEIR (TO BE REMOVED)
EXISTING BOX CULVERT
BUILDING A
BUILDING B
EXISTING BUILDING (TO REMAIN)
EXISTING BUILDINGS (TO BE DEMOLISHED)
99-TP-09
E4-TP-01
99-TP-06
99-TP-01
99-TP-08
94-TP-02
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)
APPROXIMATE CENTERLINE OF SWAN CREEK
6-FOOT-DIA. CONCRETE CULVERT
CITY LIMITS
8-INCH-DIA. CONCRETE STORM WATER OUTFALL (TO BE PROTECTED)
PIONEER WAY
BROWNING STREET
STEEP SLOPE (TYP.)
N
0 50 100
Scale in Feet
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 HAIRE WETLAND IS FROM CONCEPT PLAN BASE MAP PROVIDED BY CITY OF TACOMA, AND SUPPLEMENTED BY JURISDICTIONAL WETLAND DELINEATION PERFORMED BY CITY OF TACOMA IN AUGUST 1999.
5. ACTUAL EXTENT OF STANDING WATER ON SITE MAY VARY FROM THE INDICATED EDGES OF HAIRE WETLAND. STANDING WATER MAY EXIST ELSEWHERE ON THE SITE AND HAS BEEN OBSERVED SEASONALLY EAST OF SWAN CREEK (AS INDICATED) AND IN OTHER PORTIONS OF THE SITE.
6. 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.
7. 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.
BENCH MARK:
PROJ. MGR.: MPW
CHECKED BY: GTS
DESIGNED BY: MPW
APPROVED BY: JJW
DRAWN BY: RZC
DATE: 4/12/00
NO. DATE BY REVISION
UTILITY SERVICES ENGINEERING - DIVISION MANAGER
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PENTEC ENVIRONMENTAL
HARTCROWSER
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Seattle, Washington 98102-3699
TEL 206 324 9530 FAX 206.328.5581
FINAL DESIGN
CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS
SWAN CREEK
STREAM RESTORATION PROJECT
EXISTING CONDITIONS
DRAWING SIZE: 21x36
SCALE: AS SHOWN
DATE ISSUED: 4/12/00
DRAWING TYPE:
JOB NO.: J-718P
SHEET: 2 OF 11
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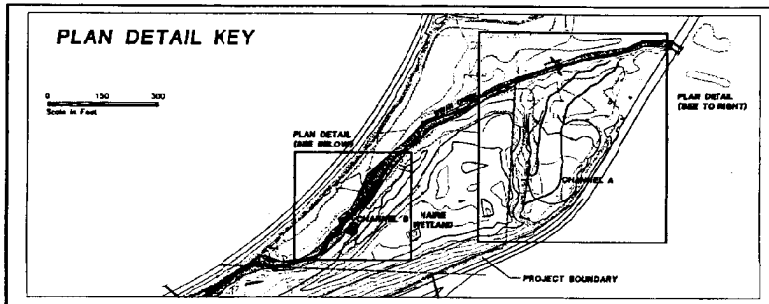
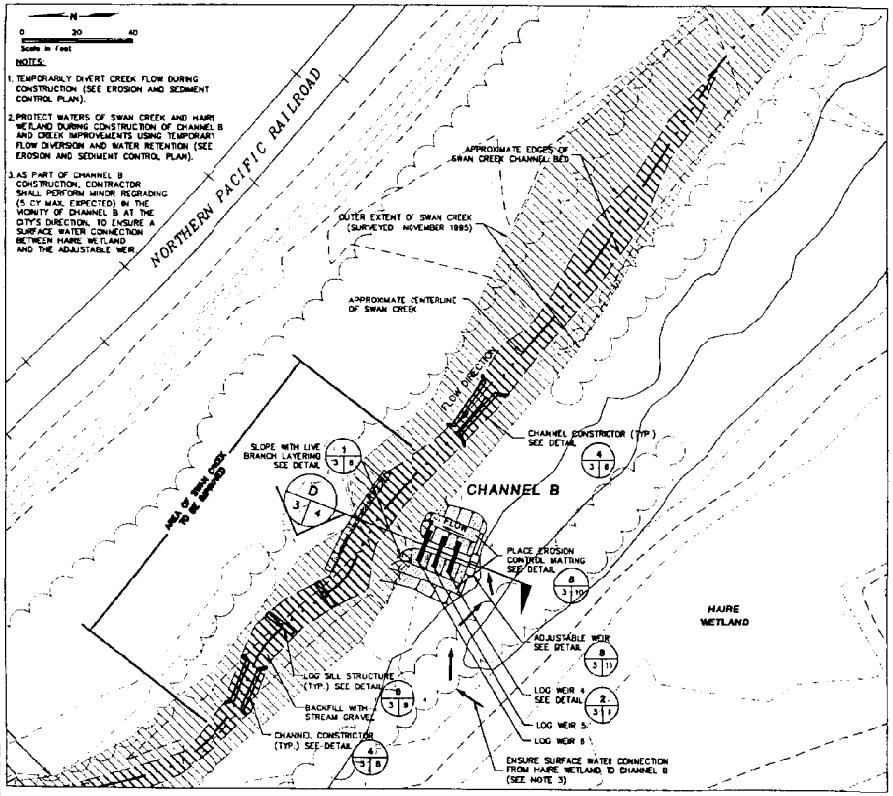
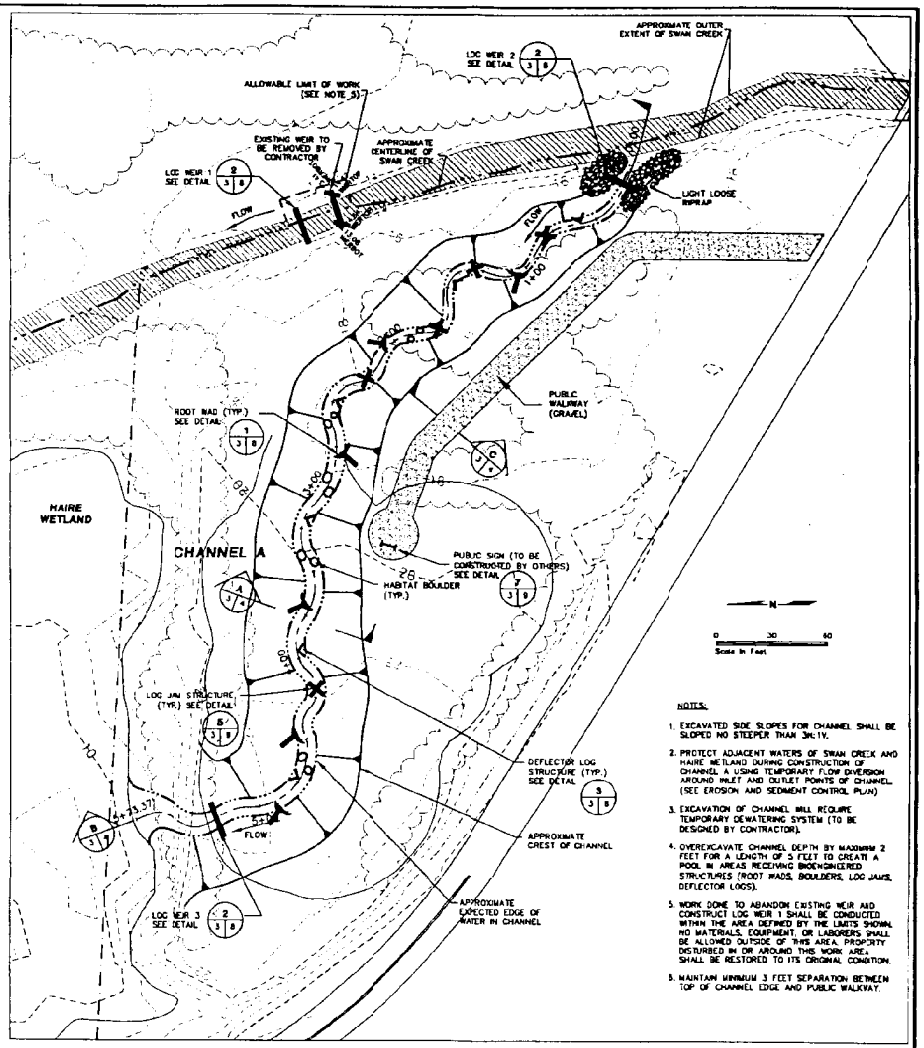




PLAN DETAIL: CHANNEL B AND SWAN CREEK IMPROVEMENTS



PLAN DETAIL: CHANNEL A

BENCH MARK:					
PROJ. MGR.: MPW	DESIGNED BY: MPW	DRAWN BY: RZC			
CHECKED BY: GTB	APPROVED BY: JJW	DATE: 4/12/00			
NO.	DATE	BY	REVISION		

UTILITY SERVICES ENGINEERING – DIVISION MANAGER

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FINAL DESIGN

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

SWAN CREEK STREAM RESTORATION PROJECT
CONSTRUCTION PLAN

DRAWING SIZE: 24 x 36	SCALE: AS SHOWN	DATE ISSUED: 4/12/00	DRAWING TYPE:	JOB NO.: J-7197	SHEET: 3 OF 11

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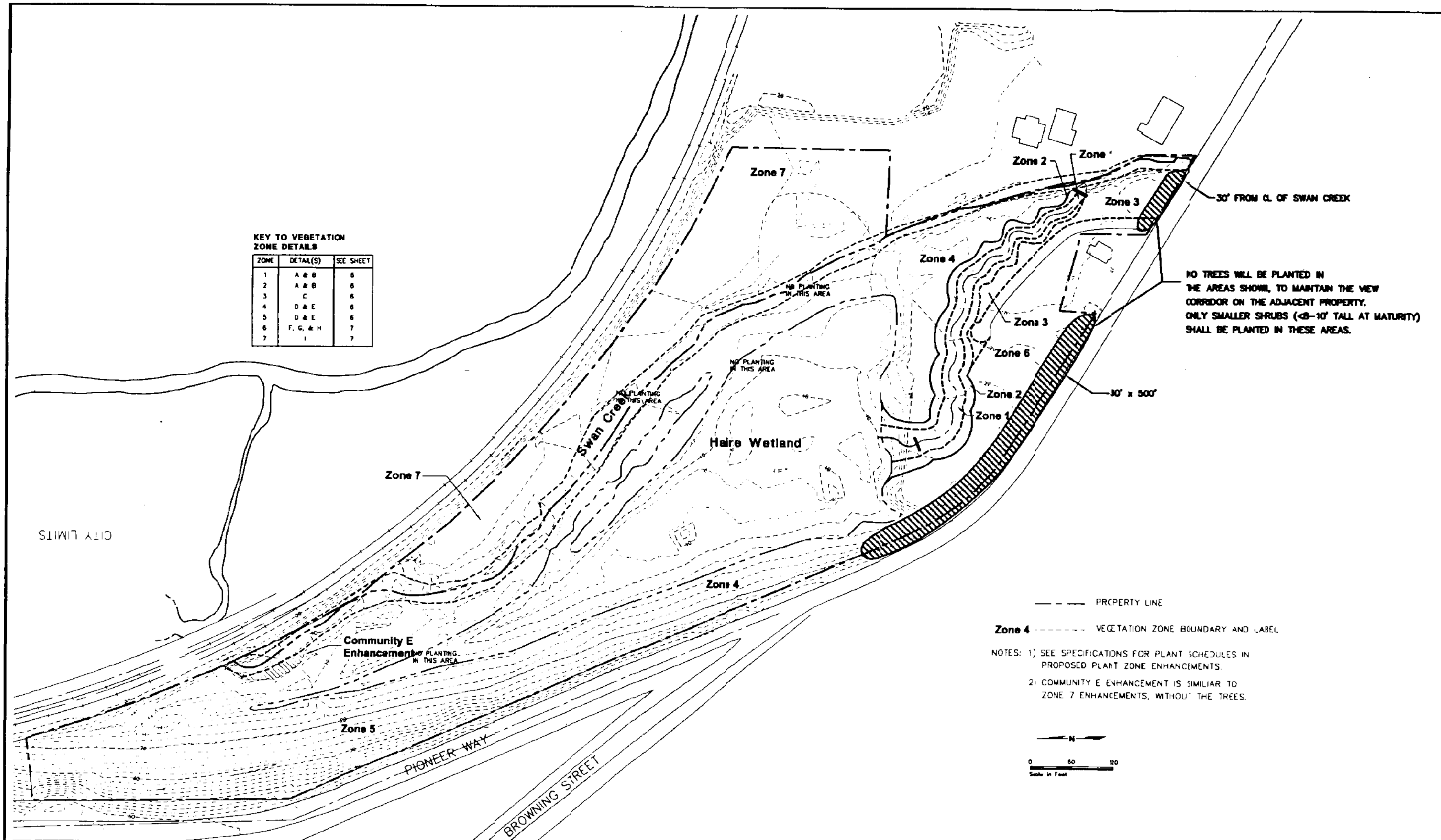
RC 4/11/00 1=1 7SS-BW.pc2 xref=BASE7197 7197004-47



KEY TO VEGETATION ZONE DETAILS

ZONE	DETAIL(S)	SEE SHEET
1	A & B	6
2	A & B	6
3	C	6
4	D & E	6
5	D & E	6
6	F, G, & H	7
7	I	7

— — — PROPERTY LINE

Zone 4 - - - - - - - VEGETATION ZONE BOUNDARY AND LABEL

NOTES:
1) SEE SPECIFICATIONS FOR PLANT SCHEDULES IN PROPOSED PLANT ZONE ENHANCEMENTS.
2) COMMUNITY E ENHANCEMENT IS SIMILIAR TO ZONE 7 ENHANCEMENTS, WITHOUT THE TREES.

BENCH MARK:					
PROJ. MGR.:	MPW	DESIGNED BY:	MPW	DRAWN BY:	RZC
CHECKED BY:	GTB	APPROVED BY:	JJW	DATE:	4/12/00
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Tel 206.324.9530 Fax 206.328.5581

FINAL DESIGN

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

SWAN CREEK
STREAM RESTORATION PROJECT
PLANTING PLAN

DRAWING SIZE: 24x36 | SCALE: AS SHOWN | DATE ISSUED: 4/12/00 | DRAWING TYPE: | JOB NO.: J-7197 | SHEET: 5 of 11

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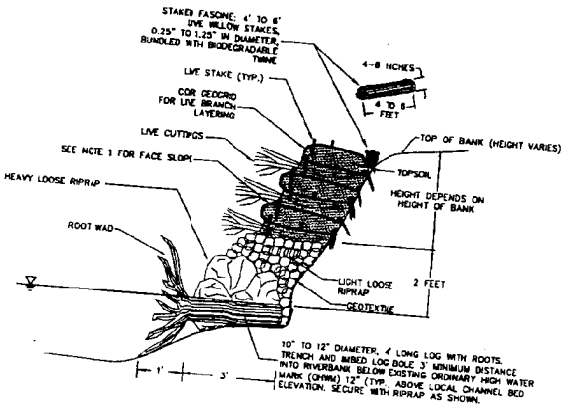


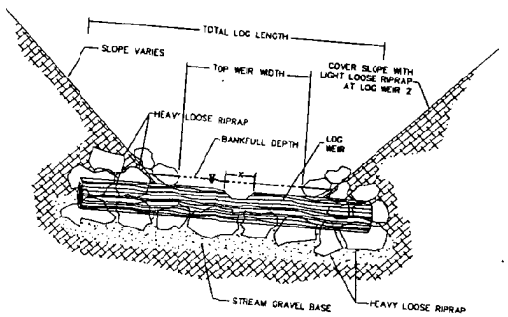
CROSS SECTION - ROOT WAD STRUCTURE

NOT TO SCALE

1 / 3 | 8

NOTE:

1. ANGLE OF FACE SLOPE FOR LIVE BRANCH LAYERING VARIES. SLOPE SHALL MATCH EXISTING BANK OR CUT SIDE SLOPE OR SHALL BE AS SPECIFIED IN THESE DRAWINGS.
2. RIPRAP AND LIVE BRANCH LAYERING SHALL EXTEND 10 FEET UPSTREAM AND DOWNSTREAM OF THE ROOT WAD.



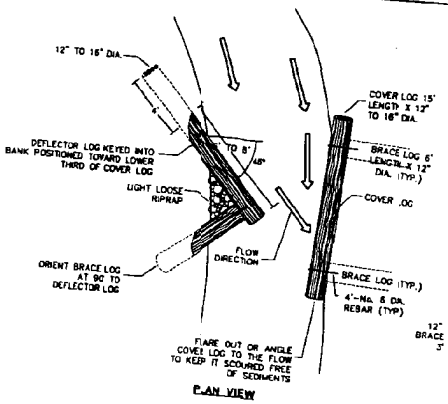
CROSS SECTION - LOG WEIR

NOT TO SCALE

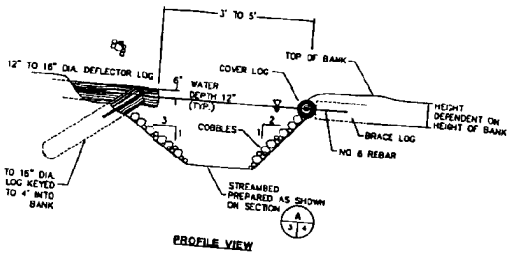
3.4|10 / 8

LOG WEIR TABLE

LOG WEIR	TOP WEIR WIDTH IN FEET	NOTCH WIDTH, "X" IN FEET	TOTAL LOG LENGTH IN FEET	LOG DIA. IN INCHES	ELEVATION OF BASE OF NOTCH	ELEVATION OF TOP OF WEIR
1	15	4	24±1	18	12'	
2	6	0	15±1	18		12' 6"
3	6	0	15±1	18		12' 3-1/2"
4	4	1	10	18	(NO NOTCH)	10'
5	4	1	10	18	(NO NOTCH)	11'
6	4	1	10	18	10'3-1/2"	10' 7"
					10'2-1/2"	
					9'11"	10' 3-1/2"



PLAN VIEW

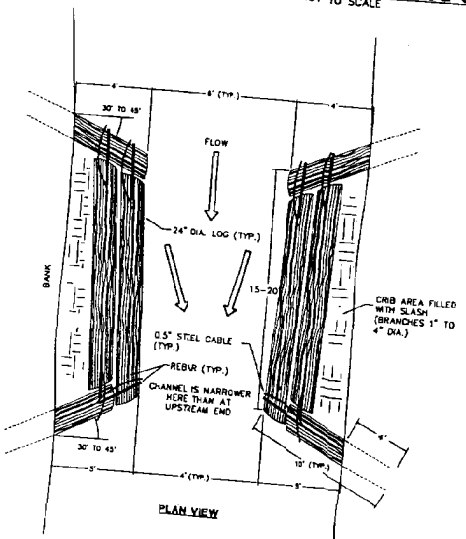


PROFILE VIEW

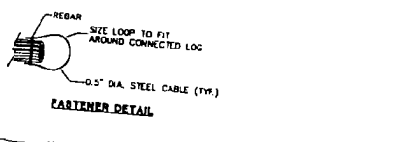
DEFLECTOR LOG STRUCTURE

NOT TO SCALE

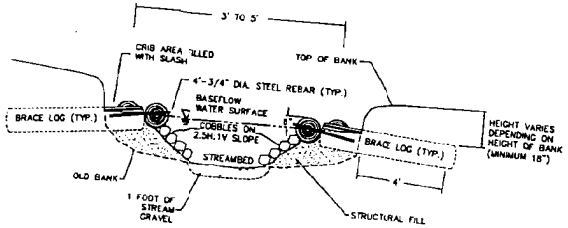
3 / 3 | 8



PLAN VIEW



FASTENER DETAIL



PROFILE VIEW

CHANNEL CONSTRICTOR

NOT TO SCALE

4 / 3 | 8

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CHECKED BY:	GTB	APPROVED BY:	JJW	DATE:	4/12/00

NO.	DATE	BY	REVISION

UTILITY SERVICES ENGINEERING - DIVISION MANAGER

PENTEC ENVIRONMENTAL

HARTCROWSER

1910 Fairview Avenue East
Seattle, Washington 98102-3699
TEL: 206.324-9530 FAX 206.328.

FINAL DESIGN

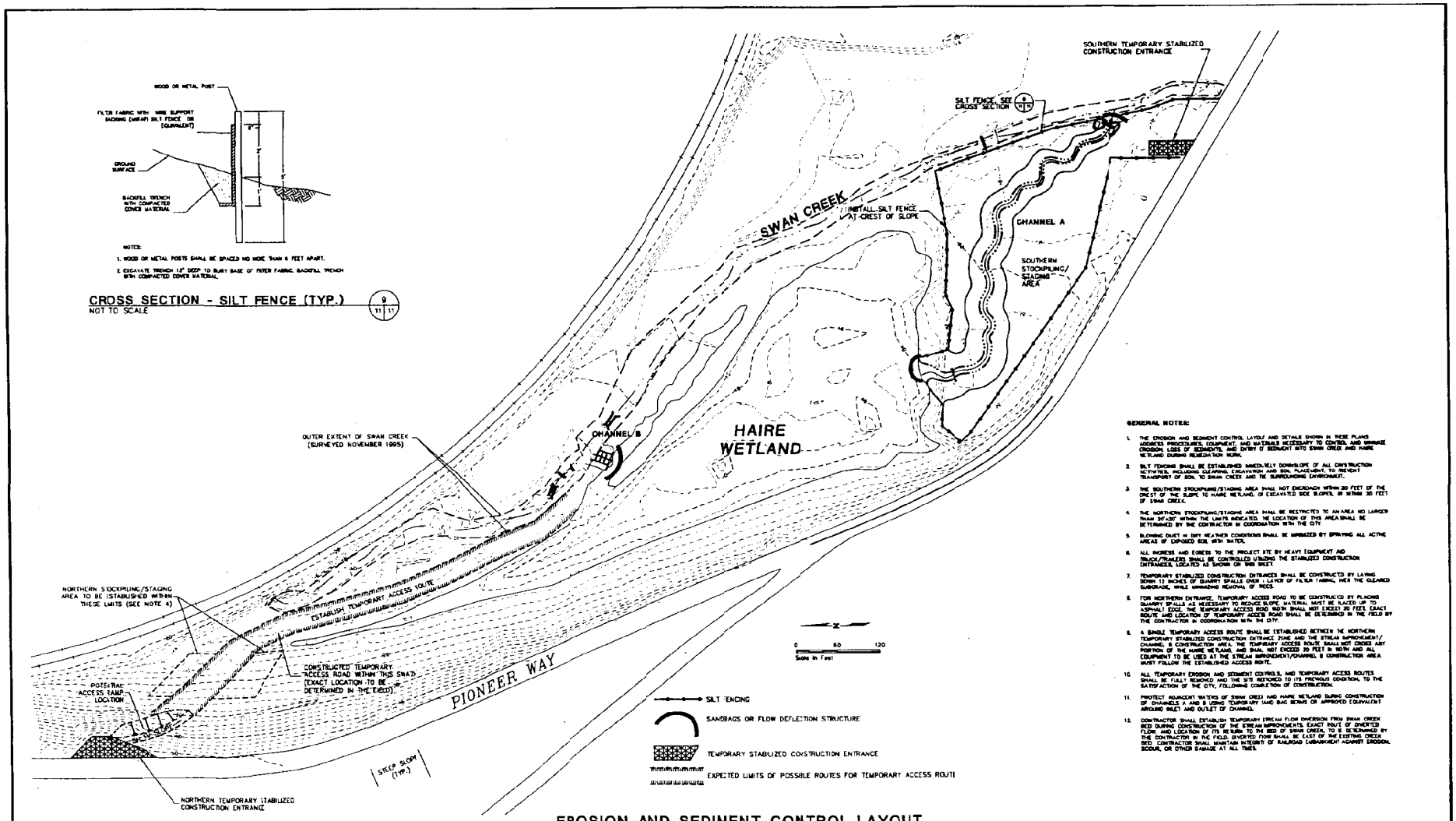
CITY OF TACOMA

DEPARTMENT OF PUBLIC W

SWAN CREEK

STREAM RESTORATION PR

DETAILS (1 OF



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 RESTORATION 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 SOUTHERN STOCKPILING/STAGING AREA SHALL NOT ENCROACH WITHIN 20 FEET OF THE CREST OF THE SLOPE TO HAIRE WETLAND, OR EXCAVATED SIDE SLOPES, OR WITHIN 30 FEET OF SWAN CREEK.
4. THE NORTHERN STOCKPILING/STAGING AREA SHALL BE RESTRICTED TO AN AREA NO LARGER THAN 30'x30' WITHIN THE LIMITS INDICATED. THE LOCATION OF THIS AREA SHALL BE DETERMINED BY THE CONTRACTOR IN COORDINATION WITH THE CITY.
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 SITE BY HEAVY EQUIPMENT AND TRUCK/TRAILERS SHALL BE CONTROLLED UTILIZING THE STABILIZED CONSTRUCTION ENTRANCES LOCATED AS SHOWN ON THIS SHEET.
7. TEMPORARY STABILIZED CONSTRUCTION ENTRANCES SHALL BE CONSTRUCTED BY LAYING DOWN 12 INCHES OF QUARRY SPALLS OVER 1 LAYER OF FILTER FABRIC, OVER THE CLEARED SUBGRADE, WHILE MINIMIZING REMOVAL OF TREES.
8. FOR NORTHERN ENTRANCE, TEMPORARY ACCESS ROAD TO BE CONSTRUCTED BY PLACING QUARRY SPALLS AS NECESSARY TO REDUCE SLOPE MATERIAL MUST BE PLACED UP TO ASPHALT EDGE. THE TEMPORARY ACCESS ROAD WIDTH SHALL NOT EXCEED 24 FEET. EXACT ROUTE AND LOCATION OF TEMPORARY ACCESS ROAD SHALL BE DETERMINED IN THE FIELD BY THE CONTRACTOR IN COORDINATION WITH THE CITY.
9. A SINGLE TEMPORARY ACCESS ROUTE SHALL BE ESTABLISHED BETWEEN THE NORTHERN TEMPORARY STABILIZED CONSTRUCTION ENTRANCE ZONE AND THE STREAM IMPROVEMENT/ CHANNEL B CONSTRUCTION AREA. THE TEMPORARY ACCESS ROUTE SHALL NOT CROSS ANY PORTION OF THE HAIRE WETLAND, AND SHALL NOT EXCEED 20 FEET IN WIDTH AND ALL EQUIPMENT TO BE USED AT THE STREAM IMPROVEMENT/CHANNEL B CONSTRUCTION AREA MUST FOLLOW THE ESTABLISHED ACCESS ROUTE.
10. ALL TEMPORARY EROSION AND SEDIMENT CONTROLS, AND TEMPORARY ACCESS ROUTES SHALL BE FULLY REMOVED AND THE SITE RESTORED TO ITS PREVIOUS CONDITION, TO THE SATISFACTION OF THE CITY, FOLLOWING COMPLETION OF CONSTRUCTION.
11. PROTECT ADJACENT WATERS OF SWAN CREEK AND HAIRE WETLAND DURING CONSTRUCTION OF CHANNELS A AND B USING TEMPORARY SAND BAG BERMS OR APPROVED EQUIVALENT AROUND INLET AND OUTLET OF CHANNEL.
12. CONTRACTOR SHALL ESTABLISH TEMPORARY STREAM FLOW DIVERSION FROM SWAN CREEK BED DURING CONSTRUCTION OF THE STREAM IMPROVEMENTS. EXACT ROUTE OF DIVERTED FLOW, AND LOCATION OF ITS RETURN TO THE BED OF SWAN CREEK, TO BE DETERMINED BY THE CONTRACTOR IN THE FIELD. DIVERTED FLOW SHALL BE EAST OF THE EXISTING CREEK BED. CONTRACTOR SHALL MAINTAIN INTEGRITY OF RAILROAD EMBANKMENT AGAINST EROSION, SCOUR, OR OTHER DAMAGE AT ALL TIMES.

BENCH MARK:					
PROJ. MGR.:	MPW	DESIGNED BY:	MPW	DRAWN BY:	RZC
CHECKED BY:	GTB	APPROVED BY:	JJW	DATE:	4/12/00
NO.	DATE	BY	REVISION		

UTILITY SERVICES ENGINEERING – DIVISION MANAGER

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FINAL DESIGN

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

SWAN CREEK
STREAM RESTORATION PROJECT
EROSION AND SEDIMENT CONTROL PLAN

DRAWING SIZE: 24 x 36	SCALE: AS SHOWN	DATE ISSUED: 4/12/00	DRAWING TYPE	JOB NO.: J-787	SHEET: 11 OF 11

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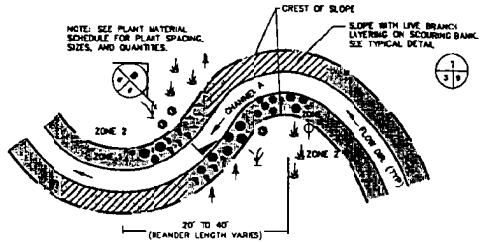
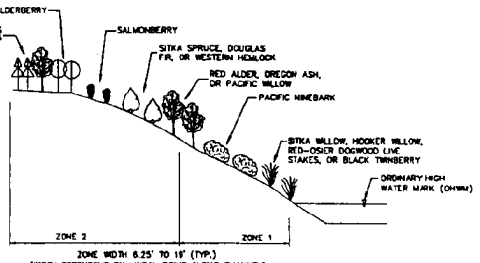
DP 4/7/00 1=1 753-ERsht3 xref=BASE7197 719/2008



ZONES 1 AND 2 TYPICAL PLANTING DETAIL (A, 5 | 6)
NOT TO SCALE

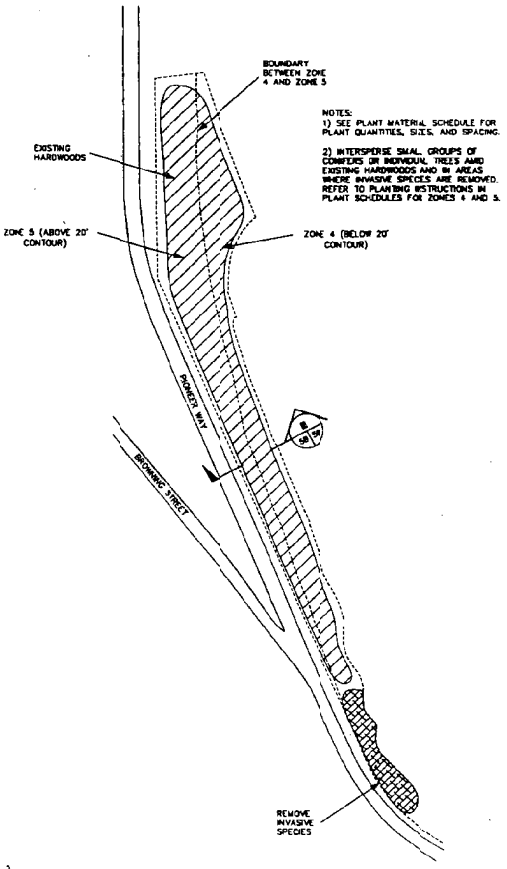
ZONE 1 (UPPER LIMIT)
ORDINARY HIGH WATER MARK (OHWM)

- RED ALDER
- BLACK TWINBERRY
- SITKA SPRUCE
- PACIFIC WILLOW
- DOUGLAS FIR
- RED-OSIER DOGWOOD
- OREGON ASH
- WESTERN HEMLOCK
- HOOKER WILLOW
- PACIFIC NINEBARK
- SITKA WILLOW

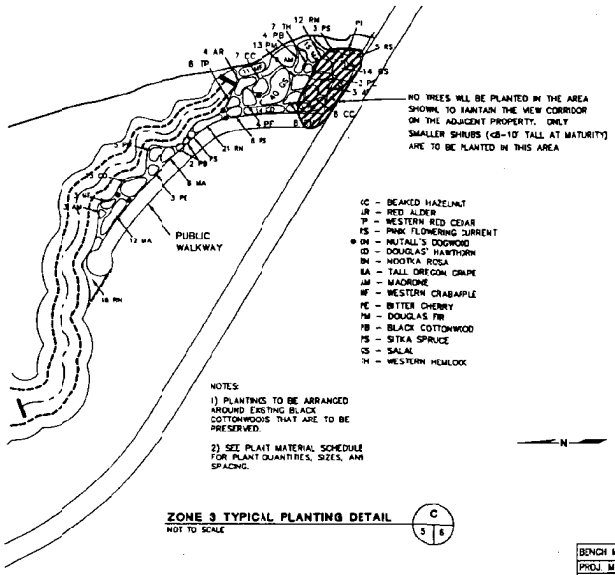


ZONES 1 AND 2 TYPICAL PLANTING SECTION (B, 6 | 6)
NOT TO SCALE

NOTE: WEST SIDE OF CHANNEL A SHOWN ONLY, EAST SIDE IS SIMILAR.



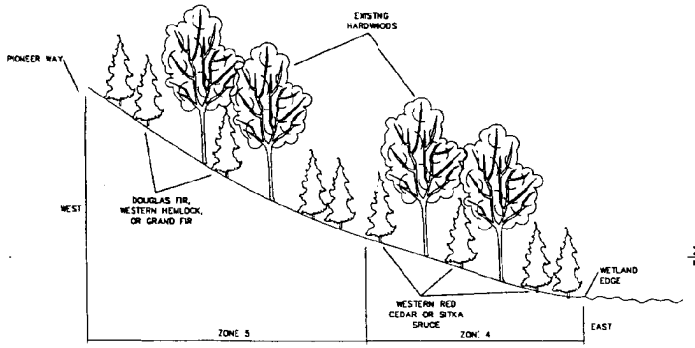
ZONES 4 AND 5 TYPICAL PLANTING DETAIL (D, 5 | 6)
NOT TO SCALE



- BC - BEAKED HAZELNUT
- RA - RED ALDER
- TP - WESTERN RED CEDAR
- RS - PINK FLOWERING CURRENT
- CN - NUTTALL'S DOGWOOD
- CD - DOUGLAS' HAWTHORN
- RN - NOOTKA ROSA
- VA - TALL OREGON GRAPE
- AM - MADRONE
- AF - WESTERN CRABAPPLE
- PE - BITTER CHERRY
- TM - DOUGLAS FIR
- PB - BLACK COTTONWOOD
- PS - SITKA SPRUCE
- GS - SALAL
- TH - WESTERN HEMLOCK

NOTES:
1) PLANTINGS TO BE ARRANGED AROUND EXISTING BLACK COTTONWOODS THAT ARE TO BE PRESERVED.
2) SEE PLANT MATERIAL SCHEDULE FOR PLANT QUANTITIES, SIZES, AND SPACING.

ZONE 3 TYPICAL PLANTING DETAIL (C, 5 | 6)
NOT TO SCALE



ZONES 4 AND 5 TYPICAL PLANTING SECTION (E, 5 | 6)
NOT TO SCALE

IF SHEET MEASURES LESS THAN 36"x24", IT IS A REDUCED PRINT. REDUCE SCALE ACCORDINGLY.

BENCH MARK:						
PROJ. MGR.:	MPW	DESIGNED BY:	MPW	DRAWN BY:	RZC	
CHECKED BY:	GTB	APPROVED BY:	JJW	DATE:	4/12/00	
NO.	DATE	BY	REVISION			

UTILITY SERVICES ENGINEERING – DIVISION MANAGER

MICHAEL P. WHEELER — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — EXPIRES

PENTEC ENVIRONMENTAL
HARTCROWSER
1910 Fairview Avenue East
Seattle, Washington 98102-3699
TEL 206.324.9530 FAX 206.328.5581

FINAL DESIGN
CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

SWAN CREEK STREAM RESTORATION PROJECT
PLANTING DETAILS (1 OF 2)

DRAWING SIZE:	SCALE:	DATE ISSUED:	DRAWING TYPE:	JOB NO.:	SHEET:
24x36	AS SHOWN	4/12/00		J-7197	6 OF 11

Appendix D— Plant Materials Schedule

Plant Material Schedule - Zone 1 (Constructed Stream Channel)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Fraxinus latifolia	Oregon ash	30	Irregular	2 gal. cont.	Individuals between groups of shrubs
Salix lucida ssp. lasiandra	Pacific willow	20	Irregular	1 gal. cont. or RC	Plant individual plants between groups of shrubs at or within ~3 ft of the ordinary high water mark (OHWM)
	Subtotal	**50**			
Shrubs					
Cornus sericea	Red-osier dogwood	80	6-9 ft o.c.*	2-3 ft live stakes	3-5 groups of 3-5 live stakes ea. or 1 gal. cont. at to about 6 ft. above the OHWM.
Cornus sericea	Red-osier dogwood	80	6-9 ft o.c.	1 gal. cont. or RC	
Lonicera involucrata	Black twinberry	120	3-5 ft o.c.	1 gal. cont. or RC	Small groups of 3-5 plants at to ~3 ft above OHWM
Physocarpus capitatus	Pacific ninebark	100	6-9 ft o.c.	1 gal. cont.	Small groups of 3-5 plants at to ~ 4 ft above OHWM
Salix sitchensis	Sitka willow	160	3-6 ft o.c.*	2-3 ft live stakes	Plant in groups of 3-5 stakes spaced 3-6 ft o.c. Intersperse and offset with groups of Hooker willow, black twinberry, and red-osier dogwood.
Salix hookeriana	Hooker willow	160	3-6 ft o.c.	2-3 ft live stakes	3-5 groups of 3-5 live stakes ea. at or near OHWM
	Subtotal	**700**			
	Total	**750**			

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* - spacing for groups of live stakes as specified in the planting instructions.

RC - rooted cutting

Plant Material Schedule - Zone 2 (Constructed Stream Channel)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Alnus rubra	Red alder	44	8-15 ft. o.c.	BR, RC, or 1 gal. cont.	Plant in groups with other hardwoods 8 to 15 ft o.c.
Fraxinus latifolia	Oregon ash	30	8-15 ft. o.c.	2 gal. cont.	Plant in groups with other hardwoods 8 to 15 ft o.c.
Picea sitchensis	Sitka spruce	24	8-20 ft. o.c.	2-3 ft. BR or 2 gal. cont.	Plant in groups with other conifers 8 to 20 ft o.c.
Pseudotsuga menziesii	Douglas fir	12	8-20 ft. o.c.	2-3 ft. BR or 2 gal. cont.	and intersperse individual trees within ex. hardwoods
Salix scouleriana	Scouler willow	24	6-9 ft o.c.	1 gal. cont. or RC	Sm groups of 2-3 upslope of shrubs in Zone 1.
Tsuga heterophylla	Western hemlock	12	8-20 ft. o.c.	2-3 ft. BR or 2 gal. cont.	Sm groups with other conifers & within ex. hardwoods
	Subtotal	**146**			
Shrubs					
Acer circinatum	Vine maple	85	6-9 ft o.c.	BR or 2 gal. cont.	Groups of 3-5 plants, esp. in shaded areas of ex. black cottonwood that will be retained.
Rubus spectabilis	Salmonberry	116	3-6 ft o.c.	1 gal. cont.	Plant in dense groups in and around hardwoods
Sambucus racemosa	Red elderberry	46	6-9 ft o.c.	BR or 1 gal. cont.	Sm groups of 3-5 plants at to 2 ft above OHWM
Symphoricarpos albus	Snowberry	94	3-6 ft o.c.	BR or 1 gal. cont.	Plant in a narrow band near the top of bank.
	Subtotal	**341**			
	Total	**487**			

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BR - bare root

RC - rooted cutting

Plant Material Schedule - Zone 3 (Public Acess)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Alnus rubra	Red alder	4	8-12 ft o.c.	BR, RC, or 1 gal. cont.	Small groups per typical planting detail
Arbutus menziesii	Madrone	12	8-15 ft o.c.	4-5 ft BB or 5 gal. cont.	Plant in groups per planting detail
Cornus nuttallii	Nutall's dogwood	5	Irregular	4-5 ft BB or 2 gal. cont.	Sm. groups & scattered ind's per typ. detail.
Populus balsamifera ssp. trichocarpa	Black cottonwood	7	8-15 ft o.c.	BR, RC, or 1 gal. cont.	Small groups & scattered individuals as shown in typical planting detail.
Prunus emarginata	Bitter cherry	10	6-8 ft o.c.	2-3 ft. BR or 2 gal. cont.	Small groups per typical planting detail
Picea sitchensis	Sitka spruce	4	8-20 ft o.c.	2-3 ft. BR or 2 gal. cont.	Plant Sitka spruce, Douglas fir, and western red cedar, and western hemlock in groups of 2-13 trees and as scattered individuals as shown in the typical planting detail.
Pseudotsuga menziesii	Douglas fir	18	8-20 ft o.c.	2-3 ft. BR or 2 gal. cont.	
Thuja plicata	Western red cedar	6	8-20 ft o.c.	2-3 ft. BR or 2 gal. cont.	
Tsuga heterophylla	Western hemlock	7	8-20 ft. o.c.	2-3 ft. BR or 2 gal. cont.	
	Subtotal	**73**			
Shrubs					
Corylus cornuta	Beaked hazelnut	15	6-9 ft o.c.	2-3 ft BR or 2 gal. cont.	Plant in groups per typical planting detail.
Crataegus douglasii	Douglas' hawthorn	27	6-9 ft o.c.	2-3 ft. BR or 1 gal. cont.	Plant in groups to deter access to channel.
Gaultheria shallon	Salal	54	3-5 ft o.c.	4" pot or 6-12" BR	Plant in groups per typical planting detail.
Mahonia aquifolium	Tall Oregon grape	59	3-6 ft o.c.	1-2 ft. BR or 1 gal. cont.	Arrange tall Oregon grape, western crabapple, pink-flowering currant, and Nootka rose in groups along public walkway for aesthetics & to deter access and trampling of streambanks.
Malus fusca	Western crabapple	17	6-9 ft o.c.	2-3 ft. BR or 1 gal. cont.	
Ribes sanguineum	Pink-flowering currant	23	3-6 ft o.c.	1-2 ft. BR or 1 gal. cont.	
Rosa nutkana	Nootka rose	57	3-6 ft o.c.	1-2 ft. BR or 1 gal. cont.	
	Subtotal	**252**			
	Total	**325**			

BR - bare root

BB - ball & burlap

RC - rooted cutting

Plant Material Schedule - Zone 4 (Riparian Reforestation)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Picea sitchensis	Sitka spruce	67	8-15 ft. o.c.	4-6 ft. BB or 5 gal. cont.	Plant in small stands of 5-15 to create
Picea sitchensis	Sitka spruce	67	8-15 ft. o.c.	1.5-2 ft. BR or 1 gal cont.	mixed aged stands of conifers amid stands of
Thuja plicata	Western red cedar	68	8-15 ft. o.c.	4-6 ft. BB or 5 gal. cont.	hardwoods, esp. in areas where invasive species
Thuja plicata	Western red cedar	72	8-15 ft. o.c.	1.5-2 ft. BR or 1 gal. cont.	such as Himalayan blackberry are removed.
Tsuga heterophylla	Western hemlock	68	8-15 ft. o.c.	4-6 ft. BB or 5 gal. cont.	**Plant western hemlock in drier portion of**
Tsuga heterophylla	Western hemlock	72	8-15 ft. o.c.	1-1.5 ft. BR or 1 gal. cont.	**this zone near the constructed channel.**
	Total	**414**			

BB - ball & burlap
BR - bare root

Plant Material Schedule - Zone 5 (Riparian Reforestation)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Abies grandis	Grand fir	25	8-15 ft. o.c.	4-6 ft. BB or 5 gal. cont.	Plant in small stands of 5-15 and as scattered
Abies grandis	Grand fir	50	8-15 ft. o.c.	1.5-2 ft. BR or 1 gal cont.	individuals to create mixed-aged stands of
Pseudotsuga menziesii	Douglas fir	20	8-15 ft. o.c.	1.5-2 ft. BR or 2 gal. cont.	conifers amid stands of existing hardwoods.
Tsuga heterophylla	Western hemlock	25	8-15 ft. o.c.	4-6 ft. BB or 5 gal. cont.	**Plant Douglas fir only in more open areas,**
Tsuga heterophylla	Western hemlock	53	8-15 ft. o.c.	1-1.5 ft. BR or 1 gal cont.	**such as where invasive species are removed.**
	Total	**173**			

BR - bare root

Plant Material Schedule - Zone 6 (Riparian Reforestation)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Acer macrophyllum	Big-leaf maple	20	Irregular	2 gal. cont.	Solitary or groups of two trees per typ. detail.
Acer macrophyllum	Big-leaf maple	40	Irregular	BR or 1 gal. container	Use larger trees in full sun.
Arbutus menziesii	Madrone	30	Irregular	4-5 ft BB or 5 gal. cont.	As shown in planting detail for Zone PA
Pseudotsuga menziesii	Douglas fir	20	8-20 ft. o.c.	1.5-2 ft. BR or 2 gal. cont.	Individuals or small groups in open areas.
Thuja plicata	Western red cedar	20	8-20 ft. o.c.	2 gal. cont.	Plant small groups of each species alone
Thuja plicata	Western red cedar	40	8-20 ft. o.c.	BR or 1 gal. cont.	and together in mixed groups and as
Tsuga heterophylla	Western hemlock	40	8-20 ft. o.c.	1-1.5 ft. BR or 1 gal cont.	solitary trees. Use larger trees in full
Tsuga heterophylla	Western hemlock	20	8-20 ft. o.c.	2 gal. container	sunlight to help reduce regrowth of weeds.
	Subtotal	**230**			
Shrubs					
Acer circinatum	Vine maple	144	6-9 ft. o.c.	BR or 2 gal. cont.	Plant in groups per typical planting detail.
Corylus cornuta	Beaked hazelnut	90	6-9 ft. o.c.	1 gal. container	Plant in groups per typical planting detail.
Gaultheria shallon	Salal	256	3-6 ft. o.c.	4" pot or 6-12" BR	Plant in groups in both full sunlight and
					partial shade per typical planting details.
Holodiscus discolor	Oceanspray	136	6-9 ft. o.c.	1 gal. cont.	Plant in groups per typical planting detail.
Vaccinium ovatum	Evergreen huckleberry	191	3-6 ft. o.c.	BR or 1 gal. container	Plant in groups per typical planting detail.
	Subtotal	**817**			
Herbs					
Polystichum munitum	Swordfern	82	3-6 ft. o.c.	1 gal. cont.	Plant around conifers.
	Subtotal	**82**			
	Total	**1129**			

BR - bare root

BB - ball & burlap

Plant Material Schedule - Zone 7 (Riparian Reforestation)

Scientific Name	Common Name	Quantity	Spacing	Size/Condition	Planting Instructions
Trees					
Picea sitchensis	Sitka spruce	34	Irregular	4-6 ft BB or 5 gal. cont.	Individual or groups of 2 trees scattered in among small stands of black cottonwood.
Populus balsamifera ssp. trichocarpa	Black cottonwood	85	8-15 ft o.c.	RC or 1 gal. cont.	plt. in small stands or groups of 3-8 trees
	Subtotal	**119**			
Shrubs					
Cornus sericea	Red-osier dogwood	732	6-9 ft o.c.	3-5 ft live stakes	3-5 plants in irregularly-spaced groups
Salix sitchensis	Sitka willow	732	6-9 ft o.c.	3-5 ft live stakes	3-5 plants in irregularly-spaced groups
	Subtotal	**1,464**			
	Total	**1,583**			

BB - ball & burlap
RC - rooted cutting

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