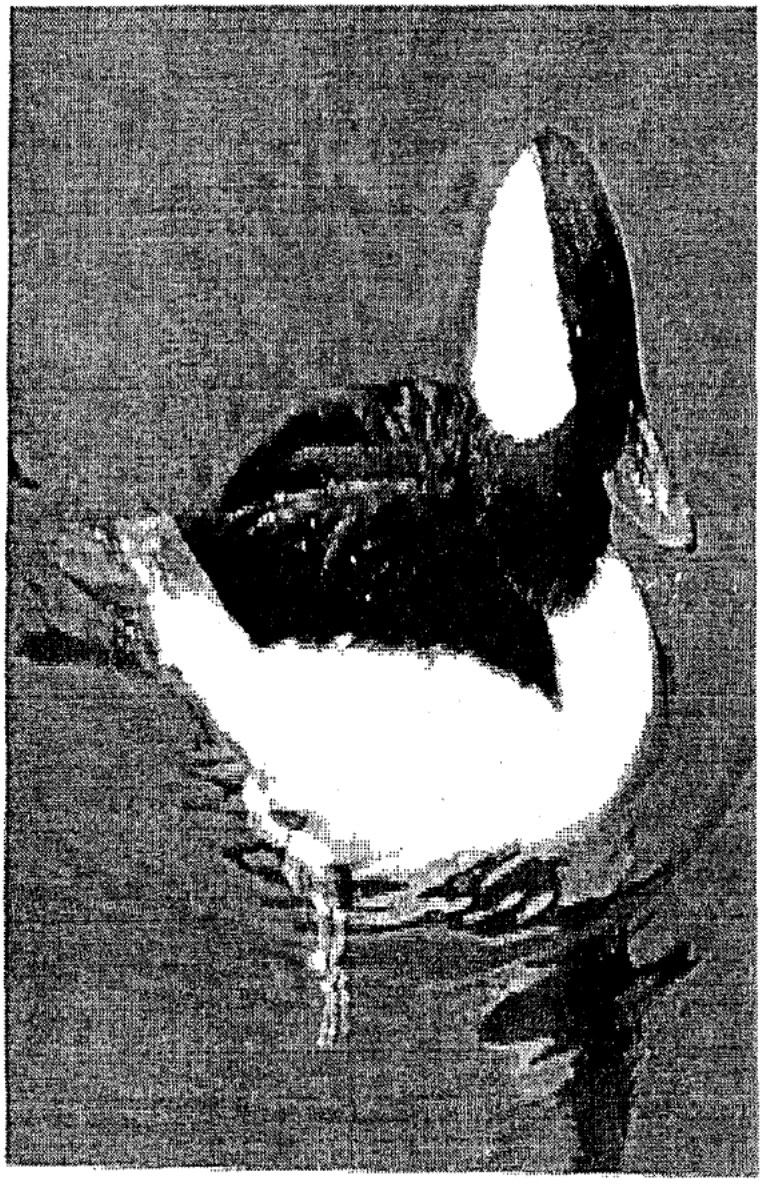
FINAL

DUWAMISH RIVER, TURNING BASIN #3 SECTION 1135 ECOSYSTEM RESTORATION AND ENVIRONMENTAL ASSESSMENT REPORT KING COUNTY, WASHINGTON



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EXECUTIVE SUMMARY

The following report proposes a plan to restore important estuarine habitat in the lower Duwamish River, and to restore fish passage and improve fish habitat in Hamm Creek, which empties into the Duwamish River. The project site is within King County, Washington, just south of the City of Seattle, at a site along the left bank of the Duwamish River near an area known as Turning Basin Number 3.

The Seattle District is conducting this feasibility level study under authority of Section 1135 of the Water Resources Development Act of 1986. King County is the study sponsor. The Turning Basin Number 3 area was degraded by the Corps' Seattle Harbor Project which was completed in 1931. The site under consideration for habitat restoration was used as a dredged material stockpiling area, with major dumps of dredged material from the 1954 to 1971. The disposal of the dredged material has totally changed the physical characteristics of the site. The site has changed from an area of productive estuarine habitat that was tidally influenced to an area of upland fill which now has relatively little importance to fish and wildlife. In addition, a small creek (Hamm Creek) that used to flow through the site was degraded by the Corps project, and the creek now provides very poor fish passage.

The parcel of land to be restored is an irregularly shaped parcel of 6.2 acres, a portion of which abuts the Duwamish River. Most of the land is now a relatively flat, grassy field, with a ditch on the western end of the parcel which contains a small perennial stream, Hamm Creek. Most of the surrounding land is industrial and of extremely limited value to fish and wildlife, however a few nearby areas have recently been improved as habitat. Hamm Creek itself has been improved as fish and wildlife habitat since the 1980's by the actions of citizen volunteers that have cleaned up trash, planted trees and shrubs, and introduced fish species. However, the problem of poor fish passage remains. Fish sampling has indicated that despite its degraded condition, the following species now use Hamm Creek: sculpins, coho salmon, and cutthroat and steelhead trout.

Many agencies recognize the need to improve fish and wildlife habitat in the now heavily industrialized Duwamish River estuary, and many federal, state, local, and tribal groups have been seeking to restore estuarine habitat and Hamm Creek in the Turning Basin Number 3 area. Several past fisheries studies have shown that young salmon smolts are stressed by the immediate exposure to full strength sea water, and they need a transition period in brackish water to avoid high mortality rates. The turning basin is located in this important transition zone.

In order to develop the best habitat restoration plan for the 6.2 acre parcel, seven options were investigated. In addition, the no action plan and a plan that would restore 21.5 acres of land was investigated. Option 1 of alternative 1 was chosen as the preferred plan. The plan had the following elements: improvement of Hamm Creek for both fish and wildlife, the elimination of a 1,900 foot long culvert for better fish passage, the creation

of two acres of fresh water marsh, and the creation of a one acre estuarine marsh. Looking at costs, environmental benefits, and sponsor and agency acceptability, option 1 was the best alternative.

The potential project would create about 2,300 feet of new Hamm Creek channel designed for easy fish passage, the planting of numerous native trees, shrubs, and wetland plants, and the excavation of slightly more than 60,000 cubic yards of material. Construction would most likely occur in the summer of 1999, and the restoration project would be monitored at three different times over a five year period following project construction. The restoration of Hamm Creek and the creation of new estuarine habitat would be a benefit to many species of fish and wildlife but would especially help anadromous fish species, which have been in significant decline recently within the Puget Sound drainage basin. The project would have no significant adverse impact on any species of fish and wildlife, nor would the project force any relocation of homes or businesses. The project has strong sponsor, agency, and tribal support.

The total construction cost estimate is $1,770,000, the real estate estimate (known as the LERRD value) is $821,000, the planning, engineering and design estimate is $390,000, the construction management estimate is $170,000, and the monitoring estimate is $45,000, for a total implementation cost estimate of $3,196,000 in October 1997 prices. The fully funded implementation estimate, which takes into account that the project would not be built until 1999, is $3,353,000. Under Section 1135 the Federal government contributes 75% of the implementation costs or $2,215,000. The non-federal sponsor's share is 25% or $838,000. The sponsor intends to provide the necessary real estate or LERRD for the project, and the sponsor's creditable LERRD (fully funded) is estimated at $ 848,000, which is $10,000 over the sponsor's 25% share. If these estimates hold up, then the Federal government would have to pay the sponsor $10,000 after project completion. The sponsor, King County, has the resources to acquire the real estate needed for this project and is actively in the process of acquiring the real estate.

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Section 1

Introduction

Section 1135 of the Water Resources Development Act of 1986, as amended, allows the Corps of Engineers to modify the structures or operations of existing Corps projects in an effort to improve the environment. The following report proposes a plan to restore important estuarine habitat in the lower Duwamish River near an area known as Turning Basin Number 3, and to restore fish passage and improve fish habitat in a stream which empties into the estuary. The lower Duwamish River estuary has been greatly impacted by dredging and dredged disposal since the Corps' Seattle Harbor Project was completed in 1931. The site under consideration for habitat restoration was used as a dredged material stockpiling area, with major dumps of Corps dredged material in 1954, 1960, 1968, and 1971.

1.1 PURPOSES OF STUDY

The purposes of this study were to determine the environmental, engineering, and economic feasibility of recreating estuarine habitat and improving stream habitat to provide benefits to fish and wildlife and to identify a non-Federal sponsor to share in the cost of project implementation.

1.2 STUDY AUTHORITY

The Lower Duwamish River, Turning Basin Number 3 Ecosystem Restoration Report (ERR) is being prepared under the authority contained within Section 1135 of the Water Resources Development Act of 1986 (Public Law 99-662), and as amended by subsequent legislation.

1.3 STUDY AREA

The potential restoration site is an irregularly shaped 6.2 acre parcel of land just south of the City of Seattle in King County, Washington (see Figure 1). The site is in the general area known as Turning Basin Number 3, which is near rivermile 6.2 on the left bank (looking downstream) of the Duwamish River. A few river miles upstream of the site the Duwamish River is called the Green River.

The Duwamish/Green River has its headwaters in the Cascade Mountain Range at an elevation of close to 4,500 feet. From there the river travels about 90 miles, first west and then north, to its mouth in Elliott Bay in Puget Sound (see Figure 2). The estuary of the Duwamish/Green River extends upstream to about rivermile 14; the lower 7 miles of the estuary is approximately the limit of dredging impacts.

The 6.2 acre parcel is within an approximately 21.5 acre area of grassy field adjacent to the urban waterway. The parcel is bounded to the south by Seattle City Light's

Duwamish substation, to the north by the Delta Marine Industries facilities, to the east by the Duwamish Waterway, and to the west by West Marginal Way Place South, a frontage road of Highway 99 (see Figure 1). An open ditch (Hamm Creek) runs along the west boundary of the property. The majority of the property is nearly flat.

1.4 LIMITS OF SCOPE

Project modifications authorized by Section 1135 are limited to structural or operational changes, or a combination of the two. Modifications must be accomplished on existing project lands or lands provided by a project sponsor, and must be consistent with the original project purpose. In the case of this particular restoration project, a structural change would be made to the land, and the land would be provided by the sponsor (King County).

The recommended plan to restore estuarine habitat at the 6.2 acre project site and to restore fish passage and habitat at Hamm Creek was selected through detailed comparison of plans, environmental benefits, and economic influences. An environmental assessment has been integrated into this report, and includes a determination on the impacts of this potential project on water quality; fish and wildlife resources; threatened and endangered species; cultural resources; hazardous, toxic, and radioactive waste; and other environmental resources and concerns. Pending review and approval of this report, construction plans and specifications (including final drawings, the construction schedule, and a final cost estimate) would be prepared and the project would be recommended for construction approval by the Northwestern Division of the Corps of Engineers.

Section 2

Project History

2.1 EXISTING PROJECT

The Corps of Engineers Seattle Harbor Project was adopted on 2 March 1919, and modified by subsequent acts. The project provided for maintenance of the Duwamish Waterway to various depths and for turning basins within the waterway. The project was completed in 1931. The upstream limit of the navigation project was at Turning Basin Number 3. The 6.2 acre potential restoration site was part of a larger area that received dredged material from the Corps maintenance dredging. Corps dredging records show that the general area received material in 1954 (220,000 cubic yards), in 1960 (294,000 cubic yards), in 1968 (375,000 cubic yards), and in 1971 (325,000 cubic yards). After that, the Corps went to open water disposal of dredged material. However, records show that a nearby yacht club also deposited some material at the site in 1985.

The impact of the disposal of dredged material at the site has totally changed the characteristics of the site. As a result of dredge material disposal, several alterations have occurred to this property. Hamm Creek historically meandered through an intertidal

marsh within the project area as it made its way to the Duwamish. That is no longer the case. As a result of the filling, Hamm Creek was placed in a ditch and then routed into a culvert, with an outfall into the Duwamish, This outfall is only accessible to fish at higher tides. Additionally, the site has changed from an area of productive estuarine habitat, that was tidally influenced, to an area of upland fill which has relatively little importance to fish and wildlife.

In June 1995, the King County Department of Metropolitan Services submitted a letter to the Seattle District requesting a Section 1135 study at Turning Basin Number 3. A final, revised Preliminary Restoration Plan (PRP) was submitted in October 1996 and eventually approved by Corps higher authority. The feasibility phase, which resulted in this Ecosystem Restoration Report (ERR), began in early 1997.

2.2 RESOURCE PROBLEMS

The disposal of dredged material on the site has resulted in two main problems that adversely impact fish and wildlife: 1) the elimination of important, intertidal, estuarine habitat; and 2) the degradation of a small perennial stream that flows through the site (Hamm Creek). The first problem is common to the entire Duwamish River estuary. In the mid 1800's, there was an estimated 590 acres of tidal swamp, 1,170 acres of tidal marshes, and 1,450 acres of mudflats in the estuary. By 1986, there was 0 acres of tidal swamp, 20 acres of tidal marshes, and 25 acres of mudflats. In other words, after a little over 100 years of urban development along the Duwamish shoreline, there is now only between 1 and 2 percent of the original shallow water habitat left in the estuary. The elimination of important estuarine habitat has led to a significant decline in fish and wildlife species in and near the river. As will be explained in more detail in other sections of this report, estuarine habitat is important to many species of fish and wildlife. One of its most important functions is that it provides critical transition habitat for salmon which are moving from a freshwater system to a salt water system. This potential project seeks to create about three acres of new wetlands (one acre of estuarine or salt water marsh, and two acres of palustrine or fresh water marsh) and was included in the list of projects supplied to Corps Headquarters under Vice President Gore's Clean Water Initiative.

The current usefulness of Hamm Creek as fish and wildlife habitat has also been severely degraded. Prior to white settlement, streams such as Hamm Creek flowed across the valley floor and converged in a matrix of forested swamps, intertidal sloughs, salt marshes, and unvegetated tide flats within the Duwamish estuary. Even very small streams such as Hamm Creek produced important salmon runs. However, Hamm Creek has been changed almost beyond recognition. The lower 1900 feet of Hamm Creek is now encased in a six foot diameter corrugated metal pipe, and the mouth of the pipe daylights at the toe of a steep, riprapped bank within the Duwamish Yacht Club (see Figure 1). During low tide, the mouth of the pipe is perched and therefore inaccessible to fish, presenting a partial barrier to both adult and juvenile fish passage. The narrow, almost vertical strip of bank vegetation near the stream outfall includes many non-native plant species with little value as fish habitat. Upstream of the pipe and within the 6.2 acre restoration site, Hamm Creek

is a nearly straight ditch. However, despite severe habitat degradation, and because of King County and citizen volunteer efforts associated with the "I'm a Pal" Foundation to restore Hamm Creek since the 1980's, salmon and steelhead runs still use Hamm Creek, making Hamm Creek one of the last self-supporting salmon bearing streams in the Duwamish estuary. With the impending listing of several species of salmon under the endangered species act, improving fish runs on Hamm Creek and the Duwamish River becomes even more critical.

2.3 ASSOCIATED STUDIES, REPORTS, AND PROJECTS

The following studies, reports, and projects have been helpful in putting together this report.

- The "Draft Hamm Creek Resource Management Plan" (May 1995) was prepared by King County Surface Water Management Division and was useful in describing the existing condition of Hamm Creek and understanding the various management options for the Creek.

- The "Sampling & Analysis Plan for the Hamm Creek Restoration Project" (April 1997) was prepared by the Dredged Material Management Office of the Seattle District Corps of Engineers and was used for background information on the Seattle Harbor Project.

- The " Sediment Characterization For The Hamm Creek Restoration Project" was prepared by the Science Applications International Corporation for the Seattle District and is included as Appendix H. This report was used to describe the chemical characterization of the 6.2 acre site.

- The "Results from 1997 Pre-Restoration Biological Monitoring of Hamm Creek, Duwamish Waterway, Seattle, Washington" (July 1997) was prepared by the Fisheries Research Institute, School of Fisheries, University of Washington for the Seattle District and is included as Appendix B. This report was used to describe the existing aquatic resources within Hamm Creek, the likelihood of restoration success, the existing vegetation in and near the creek, and the efforts of citizen volunteers to clean up the creek.

- The "Geotechnical Report for Section 1135, Turning Basin #3 Restoration Study" (July 1997) was prepared by the Seattle District's Geotechnical Branch and is included as Appendix I. This report described the soils of the 6.2 acre site and was used to help complete the final design of the restoration project.

- The "Hydraulic Design and Hamm Creek Hydrology Appendix" (Sept 1997) was prepared by the Seattle District's Hydrology and Hydraulics Branch and is included as Appendix J. The report was used to describe the existing channel and the hydraulic design and evaluation of the new hydraulic Hamm Creek channel.

- The "Section 1135 Preliminary Restoration Plan, Turning Basin Number 3 Restoration" (October 1996) was prepared by the Seattle District and served as a draft for the more detailed Turning Basin Number 3 Ecosystem Restoration Report (ERR).

- The Wetland Delineation map prepared by King County in June of 1997 was used to delineate existing wetlands in the 6.2 acre site and on the adjacent grassy field. This map can be found in Appendix A.

-The "Analysis of Restoration Alternatives and Environmental Benefits" report was prepared by the Seattle District's Environmental Resources Section in October 1997 and is included as Appendix C . The report was used to produce section 5 of the ERR.

- A "Cultural Resources Reconnaissance Report" was prepared by the Seattle District's Environmental Resources Section in October 1997. The report was used for the cultural resources background information.

- An "Economic Evaluation Appendix" was prepared by a Seattle District economist in January 1998. The report was used for the economics portion of Section 5 of the ERR. This report is included as Appendix D.

- Appendix K is the real estate appendix, and this was used to develop the real estate cost estimate within the government cost estimate.

Section 3

Existing Conditions

3.1 PHYSICAL SETTING

3.1.1 Physiography and Topography

The project site is located in the upper end (river mile 6.2) of the Duwamish estuary near the upper extent of the salt water influence, which is in the lower portion of the Green/Duwamish basin. This 500 square mile basin is located in the southeast portion of Puget Sound. The average annual discharge of the river near the 6.2 acre site is a little over 1,300 cubic feet per second. The Turning Basin #3 site was originally within the tidally influenced floodplain of the Duwamish River. However, the site and the surrounding area have been greatly impacted by the disposal of over 1 million cubic yards of dredged material and now only the edge of the property along the Duwamish River is tidally influenced or flooded by the Duwamish River. The project area and the area to the south are presently a nearly flat grassy field, with almost all of the land varying between 22 and 26 feet above sea level. The only significant relief on the site is the easternmost edge of the property which is a steep bank that drops off to the Duwamish River, and the approximately 6 foot deep ditch (Hamm Creek) on the westernmost edge of the property.

Within the project's boundary is the South Fork of Hamm Creek. This 500 acre sub-basin originates on the urbanized upland plateau south of the project area and makes up about 20% of the total Hamm Creek basin. Within the project area, Hamm Creek is contained within a ditch. This ditch leads to a culvert which goes subsurface prior to discharging through an outfall into the Duwamish Waterway.

3.1.2 Hydrology and Hydraulic Characteristics

The existing Hamm Creek channel through the 6.2 acre project site parallels West Marginal Place South and is about 1200 feet long. Both the upstream and downstream ends of the channel are bounded by culverts, the upstream culverts passing under West Marginal Place South and Highway 99, and the downstream end of the channel terminating at culverts under 96th Street. From 96th Street to the Duwamish Waterway, Hamm Creek flows through a maze of culverts approximately 1,900 feet long. The channel (resembling a ditch) that parallels West Marginal Place South is approximately trapezoidal shaped with a bottom width of about 8 feet and side slopes of 1 vertical to 2 horizontal. The channel banks typically have a growth of grassy and woody stemmed vegetation, except for a short reach which is armored with riprap. Overbank flooding from Hamm Creek within the 6.2 acre site is expected to be a very rare occurrence because the ditch appears to have sufficient capacity to handle even the very rare and large storm event. Based on the hydraulic model developed for this study, channel overflow would probably occur at a discharge of slightly less than 130 cfs.

3.1.3 Climate

The climate in the lower basin and at the 6.2 acre site is characteristic of a mid latitude, west coast marine type climate, with cool wet winters and mild dry summers. The average annual precipitation at nearby Seattle-Tacoma (Sea-Tac) Airport is about 38 inches of precipitation, with very little snow and the great majority of the rain (about 75%) falling during the October through March period. July and August are often extremely dry.

3.2 ENVIRONMENTAL SETTING

3.2.1 Land Use

The 6.2 acre site is generally in an area of heavy industry and manufacturing (see figure 1). To the north is a boat fabrication business (Delta Marine Industries), to the south are transmission lines and the Seattle City Light Duwamish Substation, to the west is a small frontage road (West Marginal Place South) and immediately next to that is a major north-south arterial known as West Marginal Way (Highway 99). Across the river from the 6.2 acre site is the Boeing Developmental Center. Although the site is within an important industrial area, residential neighborhoods are relatively close. The City of Seattle South Park neighborhood is about ¾ of a mile north of the 6.2 acre site, and the King County Boulevard Park neighborhood is about the same distance south.

3.2.2 Biological Resources

3.2.2.a Terrestrial Resources

The 6.2 acre restoration site is part of a 21.5 acre field which is dominated by flat open grasslands with a few trees and shrubs. A 3 acre King County habitat improvement project to the west of Highway 99 contains another section of Hamm Creek, a pond, and trees and shrubs. The area surrounding the 21.5 acre field and the 3 acre site is largely industrial (see Fig 1). Within this general area use by wildlife is probably moderate but locally significant. Small mammals such as raccoon, rabbits, moles, voles and field mice currently use the area. Beaver have been known to use the general area. Large mammal access is restricted by the road network and the industrial development surrounding the area. Bird use includes such species as: red tailed hawk, killdeer, great blue heron, swallows, crow, starling and sparrows. Waterfowl (specifically Canadian Geese which are extremely abundant in the area) utilize the large wetland within the grassy field that usually is ponded during the winter months. No information on reptile or amphibian use in the project area is available although the current Hamm Creek stream/ditch may provide habitat conditions for newts, salamanders, and frogs .

3.2.2.b Wetlands and Vegetation

Currently the site supports an extensive grassland and palustrine wetland system with the ditch along the eastern portion of the project that contains Hamm Creek. Riparian or streamside vegetation along the Hamm Creek channel includes Himalayan blackberry, scotch broom, willows, alders, and other trees and shrubs. Growing within the ditch are reed canary grass and water parsley. The grassland/wetland complex that comprises the majority of the site is dominated by grass species of the genuses fescue and bluegrass with an abundance of clover in the grassland portion. The palustrine emergent wetlands on site are characterized by genuses of bentgrass, spike rush and algae. These wetlands provide limited value in comparison with envisioned restoration. There are about 24 separate isolated wetlands on the 21 acre site for a total of 1.65 acres of wetlands (see wetland map in appendix A). The majority of these wetlands range from only a few hundred square feet to 2,000 sq. ft. The two largest wetlands are 1.1 acres and 0.1 acres in size. Only about 12,000 sq. ft (less than 1/3 acre) occur within the actual 6.2 acre footprint where the project is proposed. The majority of this 1/3 acre will be converted to stream or riparian buffer. Three acres of higher value wetlands will be created as a result of this project.

The wetlands on the 21 acre site were delineated by Jamie Hartley, Jon Raybourn, and Laura Hartema of King County's Ecological Services Unit on May 19-22, 1997. As a result, Pat Cagney and Merri Martz of the Seattle District Environmental Resources Section confirmed the wetland delineation on August 15, 1997. The site is composed of fill material pumped from the Duwamish River channel during dredging operations many years ago. Currently, most of the site is grassed with a mixture of pasture grasses including Festuca arundinacea, Holcus lanatus, Agrostis sp., Poa sp., etc. The site is

frequently mowed during the growing season, so identification of plants is difficult. A total of 24 wetlands were identified by King County's Ecological Services Unit. Wetlands on the site were correctly delineated using primarily the hydrophytic vegetation and presence of wetland hydrology because the soils are not clearly distinguishable between wetland/upland due to their former life in the Duwamish River.

Soil color often reveals much about a soil's wetness, whether the soil is hydric or not. The standard evaluation to determine the soil's color is by comparing it to a Munsell soil color chart. These colors are identified by three components: hue, value, and chroma. The chroma indicates the color strength or purity in the soil. The soils across the entire 21 acre site are relatively uniform and are reduced chroma 10YR 4/1 to 3/3. Mottles are distinct and prominent in wetland areas. It is likely that the soil had reduced chroma prior to its placement as fill. Low chroma in the upland areas is a result of relic reduction. Water drains from the site into the depressions (wetlands) and ponds there during the rainy season, which includes the spring and early summer months (growing season). The soils are not helpful in determining wetland boundaries.

The vegetation found during the wet season included Agrostis alba, Eleocharis palustris, Barbarea orthocerus, Poa pratensis, etc. in the wet areas. The first indicator of hydrophytic vegetation was met (>50% of dominant plants are FAC, FACW or OBL). In upland areas, the sites were dominated by FAC and FACU grasses (Festuca arundinacea, Agrostis tenuis, etc.). At that time of year, it is evident where the wetland boundary was due to vegetation and hydrology.

In May, the hydrology was evident in some wetlands, but not others depending on how much runoff had accumulated. However, wetland drainage patterns (depression) were evident even if the soil was not saturated or ponded. In August, no water was present, however, the depressions were still obvious and had dead FACW or OBL plants present (especially Eleocharis palustris, Barbarea orthocerus, Juncus bufonis).

The proposed 6.2 acre restoration project at this site will impact approximately 1/3 acre of palustrine emergent wetlands. These wetlands are all isolated from Hamm Creek or the Duwamish River. The largest (and wettest) wetland on the entire 21 acre site is 1.1 acres and the proposed project will affect approximately 20% of this wetland (0.25 acres). These wetlands may provide some habitat for waterfowl and migratory birds, however, this function is not expected to be significant. The restoration project will create one acre of estuarine intertidal emergent wetlands and two acres of palustrine perennial emergent wetlands. These wetlands will create habitat for anadromous fish (such as steelhead and coho), resident fish (such as sculpins and gunnels), and will provide a riparian corridor for wildlife between Hamm Creek and the Duwamish River.

3.2.2.c Prime Farmlands

There are no prime farmlands within the 6.2 acre site.

3.2.2.d Aquatic Resources

Aquatic vegetation within the 6.2 acre site and along the Duwamish Waterway includes Lyngbye's sedge. There are three small plots (less than 0.05 acres total) of this adjacent to the Waterway. The project as proposed would not disturb these small patches, and they will be used as reference elevations for the creation of the estuarine marsh portion of the project. Semiaquatic grasses and aquatic plants such as watercress are present in and around the Hamm Creek channel.

Although Hamm Creek is within an industrial area and much of the channel lacks the meanders of a natural channel, the stream appears to be productive for some species of invertebrates and fishes (e.g. chironomid flies, oligochaete worms, brook lamprey). This is probably the result of a number of factors. Extensive growth of overhanging riparian and semiaquatic vegetation buffers the creek from the surrounding industrial landscape and provides refuge for fish and crayfish and habitat for the adult forms of both aquatic and terrestrial insects. The combination of a thick sandy bottom with a low gradient but actively flowing stream provides a good substrate for fish such as brook lampreys and for benthic invertebrates such as oligochaete worms, leeches, and many types of aquatic insect larvae that are found in the diets of juvenile salmon and trout. Although their exact effects are unknown, citizen action by the "I'm a Pal" Foundation in cleaning the creek bed since the 1980's and planting invertebrates have also significantly increased the productivity of Hamm Creek.

Fish species sampled in lower Hamm Creek by the Fisheries Research Institute of the University of Washington included prickly sculpins (Cottus asper), juvenile coho salmon (Onchorynchus kisutch), and cutthroat and steelhead trout (O. clarki and O. mykiss). Western Brook lamprey (Lampetra richardsoni) were extremely abundant but were not sampled by electroshocking. (Note: for additional information on aquatic resources within the 6.2 acre site, please refer to Appendix B.). Fish species in the Duwamish Waterway (of which this parcel is adjacent to) include sculpin, gunnel, several species of trout, and chum, coho and chinook salmon. Chinook Salmon has recently been proposed for listing under the Endangered Species Act.

(is listed)

3.2.3 Air Quality

The high density of industry as well as automobile emissions have caused some air quality problems in this area, but usually air quality is good. Motor vehicles are the largest source of most air pollutants in King County. Local inputs from cement plants and steel mills can also be notable. Most air quality problems occur during the dry portion of late summer when weather patterns are very stable and there are only slight off-shore winds, or during mid-winter during stable periods of thermal inversions. Particulates, sulfur dioxide, ozone and carbon monoxide are the pollutants of concern.

3.2.4 Cultural Resources

An archeological reconnaissance was conducted on the 6.2 acre site in August 1997, the National Register was checked, and the boreholes from the Geotechnical testing were checked. The closest National Register eligible prehistoric site is the Duwamish No. 1 Site located downstream just a few miles. Previous inventory along the river failed to disclose evidence for cultural sites at this location. During the August reconnaissance, no exposure of prehistoric or historic material was observed, and no features of cultural interest were identified. This information was supplied to the State Historic Preservation Office.

3.2.5 Aesthetics and Recreational Resources

This reach of the Duwamish River is an urban, industrialized waterway and most people would probably not consider this a particularly scenic area. Despite this, the river is a major navigable river within a large metropolitan area, so even the industrialized waterway does receive some recreational boating and fishing use. The grassy field and the Hamm Creek ditch on the 6.2 acre site receives very little recreational use and the land is not public land. However, there have been considerable efforts to improve the Hamm Creek ditch for fish and wildlife (such as trash removal and tree planting) and this activity has made Hamm Creek more aesthetically pleasing. The Hamm Creek area just upstream of the ditch and on the western side of West Marginal Way has recently been improved as fish and wildlife habitat by King County and the "I'm a Pal" Foundation, and that has improved the aesthetics of the area.

3.2.6 Water Quality

Concerning water quality, the Duwamish River segment of the Duwamish/Green system contains intense industrial development and is the only section of the river system designated as Class B (good) waters. Upstream of the Duwamish River the waters are classified as Class A (excellent) or even Class AA (extraordinary).

King County's Sub-basin 6 (which the 6.2 acre site is a part of), forms the eastern boundary of the Hamm Creek watershed. Land use within the basin consists of about 55% residential and industrial and 45% open space (most of the open space is two golf courses). The current conveyance system for much of the creek is a combination of man-made straight ditches and pipe culverts. According to King Co. (1987[1]), surface water runoff from residential areas has contributed to erosion and sedimentation in the South Fork of Hamm Creek. In addition to sedimentation and other pollutants common in urban runoff, nutrients, pesticides, insecticides and fungicides may be contributed to the

[1] King County. 1987. Basin reconnaissance report #26: Duwamish River Basin. Vol.III of the King County Basin Reconnaissance Program Summary. Seattle. WA

stream by golf course operations. Approximately three acres of Highway 99 surface area drain to the lower portion of South Fork Hamm Creek[2].

Flow in Hamm Creek is a mixture of surface runoff and ground water inflows where the shallow, upper aquifer is intersected by the channel. During dry summer periods, flow in the creek is generally from ground water inflows only. In 1995 a stream discharge and water quality gage within the 6.2 acre site was installed. For one year of data, the gage showed that the maximum flow of water in the ditch was about 27 cfs, while the minimum flow was about 0.2 cfs. The average mean daily discharge at the gage was 1.7 cfs. The channel bed material is poorly graded sand with silt and gravel.

3.2.7 Threatened and Endangered Species

By letter dated September 15, 1997, the U.S. Fish and Wildlife Service stated that the only Federally listed species that may be present within the area of habitat restoration is the bald eagle (Haliaeetus leucocephalus). The letter stated that wintering bald eagles may occur in the vicinity of the project from about October 31 through March 31, and the concerns are the level of use of the project area by bald eagles, the effect of the project on eagles' primary food stocks and foraging areas in all areas influenced by the project, and impacts from project construction and implementation (e.g., increased noise levels and increased human activity) which may result in disturbance to eagles and their avoidance of the project area. In addition, the letter stated that the following "species of concern" may occur in the vicinity of the project: bull trout (Salvelinus confluentus) and river lamprey (Lampetra ayresi).

The chinook salmon in the Duwamish River, but which does not appear to be present in Hamm creek, has been proposed for listing under the Endangered Species Act. Note: for additional information on aquatic resources within the 6.2 acre site, refer to Appendix B.

3.2.8 Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," asks that each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. As will be discussed in later sections of this report, this potential habitat restoration project is close to a neighborhood that has both a significant minority population and a low income population. This potential project will seek to improve the physical environment at the project site.

[2] Herrera Environmental Consultants, Inc. 1994. South 96th Street Water Quality Engineering Report. Washington Department of Ecology.

3.2.9 Hazardous, Toxic, and Radioactive Waste

In 1997, the Science Applications International Corporation (SAIC) conducted a chemical analysis of the 6.2 acre site, and then followed that with a biological assay. The results of this work indicated that soils near the Duwamish River and within the site were, in general, not highly contaminated. The Corps' Environmental Engineering and Tech Section then reviewed the results of the analysis and concluded that there were no hazardous, toxic, and radioactive waste (HTRW) concerns at the 6.2 acre site. However, the bioassay testing indicated that the soil was unsuitable for open water disposal under the Puget Sound Dredged Disposal Analysis (PSDDA) program. Should the restoration project be authorized for construction and funded, then excavated material from the 6.2 acre site would have to be hauled to a suitable upland disposal site. The level of chemicals of concern should not prohibit the usage of this material at most upland sites.

3.3 SOCIAL AND ECONOMIC SETTING

3.3.1 General setting

The 6.2 acre site is located in King County just south of the city of Seattle (1990 population 516,259) in a highly urbanized area. Land use in the area is predominantly industrial and commercial, supporting trade and other industries. The 6.2 acre site is located along the Duwamish Waterway, which supports much container and other shipping, recreational boating, and fishing by both Indians and non-Indians. This undeveloped site has been severely degraded and represents an important restoration opportunity. Relatively few undeveloped parcels of land exist along the Duwamish Waterway.

3.3.2 Transportation

Major north-south highways near the 6.2 acre site include Highway 99 (West Marginal Way) which is immediately to the west of the site, and Interstate 5 (the main north-south corridor in western Washington) which is slightly less than one mile to the east. An Amtrak line is also slightly less than one mile to the east. Two major airports are close by: Boeing Field, King County International Airport is about 1.3 miles to the north of the 7 acre site and Seattle-Tacoma International Airport (or Sea-Tac Airport) is about 4.7 miles to the south.

3.4 FUTURE CONDITIONS WITHOUT PROJECT

If a Corps of Engineers Section 1135 restoration project did not occur at the 6.2 acre site, then there would be a high probability that the site and the adjacent grassy field would be developed for commercial or industrial uses, and the ability to improve the lower portion of Hamm Creek would be lost. The 21.5 acre parcel (which includes the 6.2 acres) is owned by the city of Seattle. Much of this land will eventually be developed as a training

facility by Seattle City Light for electric utility workers. The design of the irregularly shaped 6.2 acres is the result of years of effort by the land owner, agencies, and tribes to develop a workable compromise whereby Seattle City Light could achieve their objective for the utility training center, and the agencies could achieve their objective to improve fish and wildlife habitat. Without the restoration project, the entire 21.5 acres would most likely be used by Seattle City Light for their training facility. The lower portion of Hamm Creek would continue to be degraded, with signficant impediments to fish passage.

While it is possible that the habitat restoration project could be built without using Section 1135 authority, it is not likely. Most of the agencies and tribes that are supporting habitat restoration do not have the additional financial resources to accomplish such a project on their own. Many of these same resource agencies have provided funding to King County to purchase the land easement.

Section 4

Problems, needs, and opportunities

4.1 PROJECTS AND PLANS BY OTHERS

The main problem and need within the Duwamish Waterway is to restore important estuarine habitat that has been destroyed by dredging and the deposition of dredged materials along the waterway, and to restore the health of creeks such as Hamm Creek. The natural resource problems, needs, and opportunities in the study area have been discussed by many agencies and individuals over the last several years, and several restoration projects have already been completed. The following is a discussion of some of the actions that have occurred at and near the 6.2 acre site to restore the Duwamish River estuary.

There is a Coastal America demonstration project about 0.4 miles south of the 6.2 acre site (see Fig 1). This demonstration project was completed in late 1994 and is similar in scope to the proposed Section 1135 project. It too involved the removal of dredged material to restore the shoreline to its natural shallow water habitat. The U.S. Fish and Wildlife Service, the Environmental Protection Agency, the Corps of Engineers, and the Port of Seattle were primarily responsible for the development of this nearby Coastal America Project. The success of this project has encouraged the Corps, King County, and other agencies to continue these types of restoration projects in the lower Duwamish River estuary.

There is also a Hamm Creek restoration project (a King County and "I'm a Pal" Foundation project) just on the west side of West Marginal Way (Highway 99), and immediately upstream of the section of Hamm Creek that flows through the 6.2 acre site (see Fig 1). This restoration project consists of the creation of a stretch of natural stream bed, construction of a small freshwater pond and wetland connected with the stream, and the planting of riparian vegetation. This project was completed in 1997. This

improvement would link up with the proposed Section 1135 project, and many of the fish which would use the 6.2 acre site would migrate upstream to the King County site. King County also has plans for additional fish habitat work along the South Fork of Hamm Creek during 1998, upstream of the work performed in 1997.

In addition, a citizen activist ((b) (6)) and the "I'm a Pal" Foundation with hundreds of volunteers have been working with the County and others for 18 years improving habitat within the 6.2 acre site and on adjacent sites. Mr. (b) and other volunteers have removed several tons of trash from the area, reintroduced insect larvae and crayfish from other area creeks, planted thousands of trees and other various aquatic and riparian vegetation, and reintroduced a variety of salmonids from Western Washington beginning in 1980.

Looking at the entire Duwamish/Green watershed, there are several plans to restore habitat. They include:

- Norfolk Combined Sewer Overflow clean-up project which is just upstream of the project area.
- Kenco Marine, the property adjacent to the project site has been purchased.
- North Wind weir, this project is about a ¼ mile downstream and attempts to restore one acre of intertidal marsh.
- Port of Seattle mitigation site, this project is located just down stream from the project, in between the Coastal America site and Kenco marine. About 2 acres of intertidal habitat will result from the mitigation and a derelict ferry vessel will be removed.

All of these projects are in close proximity to the Turning Basin site. This additional restoration will complement what is proposed at the site and benefits should be compounded due to these other actions.

The watershed is in the region of Option 9 of the President's Forest Plan, and as a result, watershed restoration projects under this plan will occur in the general project vicinity. The U.S. Forest Service has recently conducted a watershed analysis in the upper basin which will serve as the basis for land use planning, including habitat restoration. Also, the Duwamish/Green has been chosen as a basin to be evaluated by the U.S. Geological Service's National Water Quality Assessment Program which will examine trends in water quality and fisheries habitat over the next several years. There are currently two local watershed activity groups organized in the basin that have focused on habitat improvements in the area: the Duwamish Coalition and the Green-Duwamish Watershed Alliance. There has been much attention placed on improving the health of the Duwamish/Green ecosystem by both federal and local interests in recent years. The proposed Section 1135 project, if implemented, would complement any other restoration activity implemented anywhere within the watershed.

4.2 IMPORTANCE OF THE PROJECT TO MIGRATORY FISH IN THE DUWAMISH

As will be further explained in sections 5 and 6, the Turning Basin #3 project attempts to provide a number of biological amenities to a wide variety of fish and wildlife. Project

components such as wetlands and riparian plantings of trees and shrubs chosen for their ability to provide food and refuge to small mammals, passerine birds and waterfowl, are examples of this. However, it will be anadromous fish that stand to benefit most from habitat restoration at the 6.2 acre site. This is appropriate because many of the salmon stocks within the Green-Duwamish basin are rapidly declining. In 1998, Chinook salmon were proposed for Threatened Status under the Endangered Species Act in the Duwamish River basin. The Turning Basin #3 site offers the last unique opportunity to provide salmon two distinct and limited habitats in the lower Duwamish estuary. The project location provides the juncture of a low gradient stream (that still retains significant salmon spawning and rearing habitat in an urbanized surrounding) with a brackish intertidal marsh and mudflat. Historically, prior to urban development along the Duwamish River, there were several creeks that entered into sloughs or marshes and then into the estuary. Over time, many of the sloughs were filled and the creeks were routed through storm drains only to enter the system through outfall structures. Hamm Creek, if removed from its long subsurface culvert, probably represents the last urban stream in the lower Duwamish that has a potential to be a free running creek (unlike nearby Longfellow and Puget creeks that are largely confined to storm drain systems). This particular project will provide benefits both to the downstream migratory fish of the Duwamish/Green River as well as those fish native to Hamm creek.

Secondly, location of restoration sites is important to the productivity and success of any project. Many ocean bound salmon migrate to the sea as sub-yearlings, spending but a few months in freshwater. *These are the fish most dependent upon estuarine habitat* similar to what will be restored under this project. Several past fisheries studies have shown these young smolts are stressed by the immediate exposure to full strength sea water. They need a transition period in brackish waters or they develop signs of stress which results in higher mortality rates. The turning basin is located in this important transition zone where fresh river water moderates the higher salinity of the estuary. In addition to the osmoregulatory needs of many salmon, smolt migration is the crucial time to feed and put on weight prior to ocean disbursal. The amount of weight and length a given salmon smolt gains during this time reflects its chances for survival at sea. This has profound implications for an urbanized area that has lost much of the best habitat for rearing. This project can supply that habitat need for some salmon. The mud flats that presently occur at the site, combined with the estuarine marsh that would be constructed, provide the exact prey resources young salmon require.

The entrance to Hamm Creek, if improved in the manner that is recommended in sections 5 and 6 of this report, offers several amenities to anadromous salmon. The improved fish passage would allow access to suitable over-wintering rearing habitat for salmon smolts in the form of wetlands constructed at this site and the adjacent King County/"I'm a Pal" restoration project across the highway. Adult fish that return to spawn in the creek also stand to benefit greatly as their passage upstream is facilitated by the removal of partial blockages. The woody debris that will be placed in the stream channel will also provide pools to rest in during their homeward migration. Several features incorporated in this

project will also increase fisheries productivity for the overall Hamm Creek system. Spawning gravels will be placed towards the upstream limit of the project.

The importance of this project for migratory fish in the Hamm Creek Basin and the Green/Duwamish River has been emphasized earlier in this report, but the situation for anadromous fish is so desperate that it bears repeating. In 1997 steelhead trout returns were very poor. Although not listed as an endangered species, the entire Green/Duwamish River has been closed to steelhead fishing. In 1997 only two steelhead had returned to the river to spawn. During the fish sampling conducted in Hamm Creek for this study, several steelhead smolts were found to be residing in the creek.

As will be explained in sections 5 and 6, additional enhancements within the project include wetland construction and vegetation plantings. These enhancements will have a dual benefit of providing the food and nutrients needs of the fish that utilize the creek as well as providing some temperature attenuation (due to shade) during those critical summer months when in-stream temperatures climb.

Section 6 provides a complete description of the proposed restoration project and the environmental benefits that would result.

Section 5

Plan Formulation

During the feasibility study, planning efforts were directed toward formulating a viable alternative that would restore the important estuarine habitat and improve fish passage at Hamm Creek on the 6.2 acre site.

5.1 FEDERAL OBJECTIVE

The Federal objective of water and related land resources planning is to restore the environment in an economically effective manner (using both monetary and non- monetary benefits), pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Resource planning must incorporate a multi-objective planning process where economic, social, and environmental considerations must all be taken into account. During the formulation process associated with this study, three general alternatives were considered: The no action plan, alternative 1 which would restore 6.2 acres of land, and alternative 2 which would restore 21.5 acres. The 6.2 acre parcel associated with alternative 1 is located within the 21.5 acre parcel associated with alternative 2. For various reasons, the full 21.5 acre parcel is not for sale and as such alternative 2 is not really a viable option. However, the costs and benefits associated with this alternative were investigated to compare with the costs and benefits associated with alternative 1. The 6.2 acre parcel is a viable option in that the landowner and King County are presently negotiating for the necessary easements for this parcel, and the landowner (Seattle City Light) hopes to soon make this land available for the restoration project.

Seven options for alternative 1 were considered so that the best project for the 6.2 acre parcel could be devised.

Appendix C is the plan formulation appendix, also entitled "Analysis of restoration alternatives and environmental benefits," and Appendix D is the "Economic Evaluation" Appendix. These appendices explain in detail how the alternatives and options were chosen, what they consist of, and how they were ranked as to effectiveness. Chapter 5 summarizes the results of these appendices and the plan formulation process.

5.2 GOALS AND TECHNICAL PLANNING OBJECTIVES

The two main goals of the study have already been stated: 1) to restore important estuarine habitat along the Duwamish Waterway, and 2) to restore and improve fish passage and habitat along Hamm Creek. Keeping these goals in mind, using the planning that had already taken place by other agencies, and taking into account the desires of the land owner (Seattle City Light), the sponsor (King County), the Corps, the Tribes, and the fish and wildlife agencies, many technical planning objectives were then developed that guided the development of the restoration plan at the 6.2 acre site. The following are 9 of the technical planning objectives which were used to guide the formulation and development of the proposed restoration. As the feasibility study progressed, the 9th technical planning objective (twin culvert improvement at upstream end of project) was eventually dropped. It was determined that the twin culverts were actually not a significant impediment to fish passage, and it was no longer necessary to consider adding a vault to the median strip along Highway 99.

1. All restoration work is to be accomplished within the boundary of the 6.2 acre site. In addition, the restoration work must avoid impacts to existing transmission poles and lines, and the ordinary high water mark of 11.8 feet must be maintained in the northeast corner of the project.

2. To facilitate easy fish passage along Hamm Creek, the objective is to have no reach of the creek slope greater than 2%.

3. On the portion of the 6.2 acre site adjacent to the Duwamish Waterway, the objective is to maximize the amount of intertidal habitat that ranges in between +12 and +6 feet MLLW, while staying within the project boundary.

4. To maximize stream bank revegetation and thereby improve fish and wildlife habitat, the objective is to avoid to the extent possible the creation of steep stream banks and to replant trees and shrubs along the entire length of Hamm Creek. However, the density of the tree plantings cannot increase flooding potential along Hamm Creek.

5. The new Hamm Creek channel is to be designed so that there is no increase in overbank flooding, and the new channel should be stable and not prone to either excessive sedimentation or erosion.

6. In the few areas where a rock wall would be needed along Hamm Creek, investigate the opportunity to cover at least a portion of the rock with soil and vegetate.

7. Because coho salmon, steelhead trout, and cutthroat trout are the primary game fish species that use Hamm Creek, the project design for Hamm Creek will be geared toward their needs and requirements.

8. The project design should not cause expensive or unusual operation or maintenance concerns for the project sponsor (King County).

9. Fish passage is to be improved through the Highway 99 twin culverts at the upstream portion of the potential project.

5.3 ALTERNATIVES CONSIDERED

5.3.1 General.

The no action alternative was developed because that plan must always be evaluated in a Corps study. The seven options under alternative 1 were developed so that the effectiveness of various project components could be tested (e.g. the effectiveness of improving fish passage under Highway 99), and alternative 2 was developed so that the effectiveness of going from a 6.2 acre restoration project to a 21.5 acre project could be tested. The following is a brief description of the alternatives and options that were considered.

5.3.2 The no action alternative.

Under this alternative there would be no changes to the 6.2 acre parcel. The following features associated with the existing condition would not change. (Figure 3 indicates where most of these features are.)

* Two constricted 30 inch diameter culverts that are approximately 200 feet long at the upstream end of the project would remain as they are now. The culverts pass underneath Highway 99 on the west side of the project area.
* Downstream of the two culverts Hamm Creek flows through a ditch that is about 1100 feet long. The ditch would remain as is.
* At the end of the ditch Hamm Creek enters a culvert which takes the creek water out to the Duwamish River. Hamm Creek would continue to run through this underground culvert.
* Hamm Creek (within the culvert) empties into the Duwamish River at an area that has very little productive marsh habitat, and this situation would remain.
* The culvert mouth would remain perched twice daily during low tide periods, impeding both adult and juvenile fish passage.

5.3.3 Alternative 1, option 1.

This alternative includes the following elements.

* There would be no change to the two 30 inch diameter culverts at the upstream end of the project.
* A new channel for Hamm Creek along the western portion of the 6.2 acre site would be created and the present 1100 foot Hamm Creek ditch would be abandoned. The new channel would resemble a more natural channel in that the channel would meander, pools for fish would be added, and woody debris would be placed in the channel. The ditch banks would be sloped at 3 horizontal to 1 vertical, and trees and shrubs would be planted on the upper slopes of the bank. The bottom width of the channel would be about 20 feet wide with a low flow channel within this area.
* The creek would no longer flow into a culvert but instead would "daylight" into a new channel along the northern and eastern portion of the 6.2 acre parcel. This new creek section would be about 1300 feet long and would resemble the new creek section along the western portion of the 6.2 acres (e.g. 3:1 slopes, meanders, pools, woody debris, planted trees and shrubs along the upper banks). In addition, about one acre of fresh water marsh would be created along the new creek corridor.
* Create a one acre fresh water marsh on the west side of Hamm Creek in the vicinity of where the new Hamm Creek channel would empty into the Duwamish River.
* Create a one acre estuarine marsh on the east side of Hamm Creek in the vicinity of where the new Hamm Creek channel would empty into the river.

5.3.4 Alternative 1, option 2.

This option includes the following:

* The twin 30 inch diameter culverts at the upstream end of the project would be retained, but a vault placed in the median strip of Highway 99 would tie into the culverts and would provide a resting place for fish using the culverts. This would provide an improved connection to the upper portion of Hamm Creek, which includes a recently restored 3 acre area with fish rearing ponds and a restored creek.
* The western portion of Hamm Creek would be improved, just as in option 1 above.
* The creek would "daylight" into a new channel along the northern and eastern portions of the 6.2 acre parcel, just as in option 1 above.
* Create a one acre fresh water marsh on the west side of Hamm Creek in the vicinity of the new stream outlet, just as in option 1 above.
* Create a one acre estuarine marsh on the east side of Hamm Creek in the vicinity of the new stream outlet, just as in option 1 above.

5.3.5 Alternative 1, option 3.

This option includes the following:

* The twin 30 inch diameter culverts at the upstream end of the project would be retained and a vault would be placed in the median strip of Highway 99, just as in option 2 above.
* The western portion of Hamm Creek would be improved, just as in option 1 above.
* The creek would "daylight" into a new channel along the northern and eastern portions of the 6.2 acre parcel, just as in option 1 above.
* No creation of a freshwater marsh in the vicinity of the new creek outlet.
* Create a one acre estuarine marsh on the east side of Hamm Creek in the vicinity of the new stream outlet, just as in option 1 above.

5.3.6 Alternative 1, option 4.

This option includes the following:

* There would be no change to the twin 30 inch diameter culverts at the upstream end of the project (no vault would be added).
* The western portion of Hamm Creek would be improved, just as in option 1 above.
* The creek would "daylight" into a new channel along the northern and eastern portions of the 6.2 acre parcel, just as in option 1 above.
* No creation of a freshwater marsh in the vicinity of the new creek outlet.
* Create a one acre estuarine marsh on the east side of Hamm Creek in the vicintiy of the new stream outlet, just as in option 1 above.

5.3.7 Alternative 1, option 5.

This option includes the following:

* The twin 30 inch diameter culverts at the upstream end of the project would be retained and a vault would be placed in the median strip of Highway 99, just as in option 2 above.
* The western portion of Hamm Creek would be improved, just as in option 1 above.
* The creek would "daylight" into a new channel along the northern and eastern portions of the 6.2 acre parcel, just as in option 1 above.
* Create a one acre, fresh water, forested wetland on the west side of Hamm Creek in the vicinity of the new stream outlet, just as in option 1 above.
* Create a one acre estuarine marsh on the east side of Hamm Creek in the vicintiy of the new stream outlet, just as in option 1 above.

5.3.8 Alternative 1, option 6.

This option includes the following:

* There would be no change to the two 30 inch diameter culverts at the upstream end of the project (no vault would be added).
* The western portion of Hamm Creek would be improved, just as in option 1 above.

* The creek would "daylight" into a new channel along the northern and eastern portions of the 6.2 acre parcel, just as in option 1 above.
* No creation of a freshwater marsh in the vicinity of the new creek outlet.
* No creation of the estuarine marsh in the vicinity of the new creek outlet.

5.3.9 Alternative 1, option 7.

This option is radically different than the other options in that it only investigates the restoration of about one acre of estuarine marsh along the Duwamish River. It does not seek to restore habitat within the entire 6.2 acre parcel nor does it improve Hamm Creek. As such, it includes the following:

* There would be no change to the twin 30 inch diameter culverts (no vault would be added).
* There would be no change to the western portion of Hamm Creek (the 1100 foot ditch would still be used).
* The creek would not be "daylighted" into a new channel (it would continue to flow into a culvert).
* No creation of a fresh water marsh in the vicinity of the new creek outlet.
* Create a one acre estuarine marsh along the Duwamish River.
* The culvert mouth would remain perched twice daily during low tide periods, impeding both adult and juvenile fish passage.

5.3.10 Alternative 2.

This option is significantly different than any of the alternative 1 options. It consists of restoring not only the 6.2 acre parcel in alternative 1, but also the grassy field adjacent to the 6.2 acre parcel. The total acreage restored would be 21.5 acres. This option includes the following:

* The twin 30 inch diameter culverts at the upstream end of the project would be retained and a vault would be placed in the median strip of Highway 99, just as in option 2 above.
* The western portion of Hamm Creek would be improved, just as in option 1 above.
* The creek would "daylight" into a new channel along the northern and eastern portions of the 6.2 acre parcel, just as in option 1 above.
* The grassy field would be converted to 11 acres of planted forest and 3.4 acres of palustrine emergent wetland.
* No creation of a freshwater marsh in the vicinity of the new creek outlet.
* Create 7 acres of estuarine marsh along the Duwamish River.

Table 1 summarizes the components of the seven options for alternative 1 and the one option for alternative 2. An "x" indicates that the option incorporates that component. For instance, under alternative 1, option 1, that option does not include modification of the twin culverts or the restoration of the grassy field, but it does include all the other

components. Note that the difference between option 2 and option 5 is very slight. The only difference is that the fresh water marsh in option 5 would include trees surrounding the marsh, and option 2 would not include trees surrounding the marsh.

PREFERRED ALTERNATIVE

TABLE 1

SUMMARY COMPONENTS OF
RESTORATION ALTERNATIVES AND OPTIONS

Project Component	Alt. #1 #1	#2	#3	#4	#5	#6	#7	Alt. #2
Modification of Twin Culverts		X	X		X			X
Abandon Ditch, Create New Creek Channel (1,100 Ft.)	X	X	X	X	X	X		X
Daylight And Create New 1,350 ft. Creek Channel	X	X	X	X	X	X		X
Restore Interior Grassy Field								X
Create Fresh Water Upland Marsh	X	X			X			
Create Estuarine Marsh	X	X	X	X	X		X	X

5.4 EVALUATION OF ALTERNATIVES

The no action alternative, the seven options for alternative 1, and alternative 2 met the nine technical planning objectives with varying degrees of success. For instance, the no action alternative did not meet any of the objectives and alternative 2 did not meet the first objective (staying within the 6.2 acre parcel). Several of the alternative 1 options did not meet objective number 9, which was to improve fish passage under the twin Highway 99 culverts (i.e. options 1, 4, 6, and 7 did not improve fish passage under Highway 99). Despite this, all alternatives were evaluated objectively, whether or not they met all of the nine technical planning objectives.

Since the benefits of restoration projects are not typically measured in monetary terms, a benefit-to-cost ratio is not used to determine project justification, and maximizing net benefits cannot be used to optimize project outputs. Cost effectiveness and incremental analysis are tools that can be used to evaluate contributions of various plans when benefits are not identified in monetary terms, but rather environmental outputs. The cost effectiveness portion of the evaluation ensures that least cost alternatives are identified for various levels of environmental output. These are referred to as efficient alternatives. The subsequent incremental evaluation evaluates changes in costs for increasing levels of environmental output. The results of an incremental evaluation do no result in a discrete decision criteria (such as the plan that maximizes net benefits), but it does provide a tool to facilitate plan selection.

To complete this type of economic evaluation, quantification of the environmental quality outputs is necessary. The conceptual level designs and costs for each plan are also required. The next section, 5.5, outlines the methodology that has been used to quantify environmental outputs. This is followed by a description of alternative project costs in section 5.6 and results of the incremental evaluation in section 5.7.

5.5 ENVIRONMENTAL BENEFITS.

A landscape ecology approach was adopted to quantify environmental benefits for this project. This approach places an emphasis on ecosystem structure and function. The evaluation process developed for this site looks at eight different ecological components incorporating aspects such as primary productivity, patch size and species diversity. These measures are surrogates for vegetative structure and habitat complexity. A detailed description of each of the measures and the approach is included in the Analysis of Restoration Alternatives and Environmental Benefits Appendix (Appendix C). A score was developed for each measure under the without project condition and each of the alternatives considered. Comparing the individual scores of the without project condition to a specific alternative indicates the improvement in environmental quality for any given alternative. A composite score was developed for each alternative that incorporates the individual ecological measure and assigns a weight to it. For this evaluation primary productivity and total edge were considered to be somewhat more important, these were each weighted 20% while the other measures were weighted 10%. The Economic Evaluation Appendix (Appendix D) includes additional detail on how the index was developed. Table 2 summarizes the scores for all of the options.

Table 2 in Appendix C list the specific benefits used for the incremental cost analysis. The concepts behind these outputs are also contained within the Appendix. It is expected that in addition to these benefits that the "end users" such as salmon and trout will see an enrichment in the local habitat by increased access to the Hamm Creek system, refuge from predators and increased food availability. Waterfowl that use the area are also expected to gain. Species such as mergansers, grebes and widgeon will also be provided with additional fund and refuse area which will increase their overall fitness and lead to higher productivity.

TABLE 2

ENVIRONMENTAL BENEFITS

Primary Productivity and Total Edge are weighed 20%
Other Variables are Weighed 10%

	No Action	Alt. 1 Option 1	Alt. 1 Option 2	Alt. 1 Option 3	Alt. 1 Option 4	Alt. 1 Option 5	Alt. 1 Option 6	Alt. 1 Option 7	Alt. 2
Primary Productivity prop. Index 20%	8.21	11.79	13.02	12.70	11.47	12.87	10.04	9.64	20.00
Patch Size (Inverse X 1000) prop. Index 10%	5.08	8.91	9.62	9.52	8.82	9.52	7.69	5.55	10.00
Mean Patch Size prop. Index 10%	6.40	8.00	8.40	8.00	8.00	8.00	7.20	7.20	10.00
Total Edge prop. Index 20%	12.08	16.54	19.32	20.00	17.22	20.00	16.54	12.77	8.79
Shannon's Diversity Index prop. Index 10%	4.44	10.44	10.22	10.00	10.15	10.59	8.74	5.85	8.74
Shannon's Evenness prop. Index 10%	5.44	10.00	9.71	9.56	9.71	9.56	8.97	6.18	9.71
Patch Richness prop. Index 10%	6.25	10.00	8.58	8.58	10.00	9.65	8.75	7.50	6.44
Interspersion Index prop. Index 10%	7.20	9.13	9.42	9.33	9.01	9.01	10.00	8.19	8.14
Total Average	55.11	84.82	88.29	87.69	84.38	89.20	77.93	62.88	81.81

* A discussion of the relevance and meaning of each of the biological measures is presented in appendix c.
The discription of how weighted scores were derived is presented in the economic appendix d.

TABLE 3
ALTERNATIVE PROJECT COST SUMMARY
Duwamish River Turning Basin Restoration
Seattle, Washington

October 1997 Price Level
(Estimate does not include OH & Profit, Eng & Design or Const. Mgmt.)

	Construction Amount	Contingency 25%	ECC	ECC, Rounded	Preliminary* Real Estate	Total Estimate	Annual Costs 50 yr @ 7 1/8
ALTERNATIVE #1							
Option No.							
1	$1,439,641	$359,910	$1,799,551	$1,800,000	$875,000	$2,675,000	$197,000
2	$1,516,755	$379,189	$1,895,944	$1,896,000	$875,000	$2,771,000	$204,000
3	$1,486,308	$371,577	$1,857,885	$1,858,000	$875,000	$2,733,000	$201,000
4	$1,409,195	$352,299	$1,761,494	$1,761,000	$875,000	$2,636,000	$194,000
5	$1,516,868	$379,217	$1,896,085	$1,896,000	$875,000	$2,771,000	$204,000
6	$1,299,233	$324,808	$1,624,041	$1,624,000	$794,000	$2,418,000	$178,000
7	$257,318	$64,330	$321,648	$322,000	$123,000	$445,000	$33,000
ALTERNATIVE #2							
Option No. 1**	$1,933,500	$483,375	$2,416,875	$2,417,000	$3,936,000	$6,353,000	$468,000

*Real Estate estimates are based on preliminary and unapproved appraisal report, numbers are used only to compare alternatives.

**Costs for alternative #2 are based on those reported in the PRP, no additional design work was completed for this option, costs are based on an October 1995 price level. The real estate estimate is based on the per acre cost derived from the unofficial appraisal, and is higher than that reported in the PRP.

5.6 PRELIMINARY COSTS FOR ALTERNATIVES, INCLUDING REAL ESTATE CONSIDERATIONS.

Costs for each of the alternatives and the options were developed to approximately the same level of detail in late 1997. Preliminary real estate figures were used for each of the alternatives and the options. The non-federal sponsor submitted unapproved appraisal information on the fee value for alternative 2 (21.5 acres) and the appraised easement value for the 6.2 acre site. Although these values were unapproved, it was felt that they were reasonable and could be used to help evaluate the plans. Table 3 summarizes the preliminary construction cost and real estate costs for each of the alternatives and options. Note that on Table 3 the total cost estimate ranges from a low of $445,000 for option 7 to a high of $6,353,000 for alternative 2. The no action alternative would of course have no cost. Annual costs based on a 50 year project period and a 7 1/8% discount rate are also shown. Note that on Table 3 most of the real estate costs are $875,000 because that corresponded with a 7.12 acre parcel at the time this analysis was performed. Option 6 is slightly less than that because that option needs about 1 acre less than the 6.2 acres (no estuary development along the Duwamish River), option 7 is much less than $875,000 because that option only needs about 1 acre of land along the Duwamish River, and the alternative 2 real estate cost is much greater because that alternative requires 21.5 acres of land. Some of the figures in Table 3 have changed since the analysis was completed in late 1997; however, these changes have been relatively slight and the changes would not have influenced the rating of the options.

5.7 COST EFFECTIVENESS AND INCREMENTAL EVALUATION.

An initial cost effectiveness and incremental evaluation was conducted on the two alternatives, including the seven options identified in the plan formulation section. A summary of the methodology and findings is summarized below.

Annualized project costs and the weighted environmental benefit score were used to conduct the cost effectiveness and incremental evaluation. Details of the evaluation are presented in the economic appendix. Alternative 2 and option 2 of alternative 1 were not cost-effective options and were eliminated from further consideration. It should be noted that the costs for alternative 1 options 2 and 5 have the same costs and there is only a slight difference between the outputs. An incremental evaluation was conducted for the remaining options. The final incremental cost information is shown below. The results indicate that option 5 or option 7 are incrementally justified. The incremental cost per incremental output of option seven is $4.25 while it increases to $6.5 for option five.

"worth it" to go from option 7 (estuary alone) to option 5 (optimal restoration for the 6.2 acre parcel) under the initial evaluation. Under the second evaluation (which excluded the culvert) the question is whether it is worth it to go from option 7 to option 1. The second incremental evaluation will be considered to identify the preferred plan. The change in the incremental cost per incremental output as well as the total implementation costs of each of the options and the reasonableness of these costs should be considered. However environmental considerations on determining whether it is worth it to move from option 7 to option 1 are critical. These are discussed below.

5.8 SELECTION OF THE PREFERRED PLAN

The choice between options 7 and 1 of alternative 1 is a difficult one because the options are very different from each other. Option 7 is attractive because it is inexpensive ($445,000) and it still restores important estuarine habitat. Option 1 is attractive because it provides a significant increase in environmental outputs (84.82) and it addresses both study goals: the restoration of important estuarine habitat, and the improvement of fish passage and habitat along Hamm Creek. Because option 1 addresses the very important goal of restoring Hamm Creek and option 7 does not, then from the standpoints of completeness and effectiveness option 1 is superior to option 7. In addition, the sponsor's preferred plan is option 1 because it addresses both goals, and this is also the choice of other state, tribal, and Federal resource agencies that have been trying for several years now to restore habitat in the Turning Basin #3 area. So from the standpoints of acceptability and partnership, option 1 is preferred over option 7. For these reasons, option 1 is also the choice of the Seattle District.

To summarize, the following is why the other options and alternatives were not chosen:

Alt. 1, option 2	Improvement of twin culverts not needed.
Alt. 1, option 3	Improvement of twin culverts not needed, and lack of freshwater pond reduces environmental benefits.
Alt. 1, option 4	Lack of freshwater pond reduces environmental benefits.
Alt. 1, option 5	Improvement of twin culverts not needed.
Alt. 1, option 6 to Alt. Option 7	Lack of freshwater pond and estuarine marsh reduces environmental benefits. Also, low productivity compared preferred plan.
	Does not address improvement of Hamm Creek, and fish passage still a problem. Not enough benefits to fish and waterfowl.
Alt. 2	Improvement of twin culverts not needed, and cost of

Initial Incremental Evaluation

Altern.	Total Project Cost	Ann. Project Cost Oct. 1997 P&C 50 yr. @ 7 1/8% ($1,000)	Environ. Benefit Index	Incre-mental Cost ($1,000)	Incre-mental Output	Incre. Cost per Output ($1,000)
No Action	$0	$0	55.1	0	0	0
Option 7, Alt.1	$445,000	33	62.88	33	7.77	4.25
Option 5, Alt. 1	$2,771,000	204	89.20	171	26.32	6.50

The results of the evaluation were presented to the local sponsor. Upon more detailed consideration of the alternatives, associated costs and outputs, it was determined that improving fish passage through the twin culverts by adding a vault in the median strip of Highway 99 was not warranted. It was determined that upstream migrating fish could pass through the culverts without much difficulty.

To determine the impact of eliminating this plan element on the results of the incremental evaluation, a second and final cost-effectiveness and incremental evaluation was completed. The alternatives that included the culvert modification were eliminated from consideration. Alternative 1 options 2, 3, and 5 each had the culvert modification, as such these options were excluded from the incremental evaluation. The results indicate that there is a change in the incremental cost of option one; the outputs are slightly less as are the costs. However, overall the mix in the incrementally justified alternatives does not change.

Incremental Evaluation Without Culvert Modification

Altern.	Total Project Cost	Ann. Project Cost Oct. 1997 P&C 50 yr. @ 7 1/8% ($1,000)	Environ. Benefit Index	Incre-mental Cost ($1,000)	Incre-mental Output	Incre. Cost per Output ($1,000)
No Action	$0	$0	55.1	0	0	0
Option 7, Alt.1	$445,000	33	62.88	33	7.77	4.25
Option 1, Alt. 1	$2,675,000	197	84.82	164	21.94	7.47

As stated earlier the incremental evaluation is a tool to help select a recommended plan. The options in the final incremental cost table, regardless of whether the culvert is included or not, represent "best buys". For this project the question is whether it is

rehabilitation relatively high. Also, additional property is not available.

Once the plan (option 1) was selected, further design and implementation components were considered for the preferred plan. The cost estimate was changed and fine tuned, and Section 6 describes option 1 in its final detail..

5.9 REAL ESTATE COSTS IN THE DUWAMISH BASIN

Land acquisition costs in an urban environment are typically high, which accounts for much of the construction cost for any habitat restoration project in an urban setting. Potential habitat restoration projects have to compete in an urban setting with potential commercial developments, and undeveloped land near the Duwamish Waterway is scarce. The real estate cost for the preferred alternative is currently estimated to be $659,350 for the 6.2 acres, or on average about $106,300 per acre. (Note: there are other real estate charges too, as will be explained in Section 6.5). By letter dated December 2, 1997, the National Oceanic and Atmospheric Administration (NOAA) informed us that real estate costs associated with the project site were actually quite reasonable when compared with other nearby urban land that had recently been acquired for habitat restoration. In the Seaboard Lumber site, which is downstream of the Turning Basin Number 3 site, 15.7 acres of land was acquired for $2,500,000, which works out to about $159,200 per acre. At the upstream North Wind Weir site, the 1.03 acres of habitat cost about $404,000 per acre.

In a similar real estate exercise, the Seattle District looked at the Turning Basin Number 3 site and eight other properties near the Duwamish Waterway and ranked them according to price per square foot. The prices ranged from a low of $4.48 per square foot to a high of $8.96. The Turning Basin Number 3 site included the grassy field adjacent to the 6.2 acre parcel, and its cost was estimated at $7.50 per square foot. However, when the grassy field is eliminated from consideration, and just the remaining 6.2 acre site is left, then the price per square foot was the least expensive of the properties.

Section 6

Description and Evaluation of the Preferred Plan

6.1 PLAN DESCRIPTION

6.1.1 General

The preferred plan was previously described in Section 5 of this report as option 1 of alternative 1. This section will discuss the preferred plan in much more detail.

The proposed design consists of a new, approximately 2,300 foot long channel (see figure 4). The upstream end of the channel starts at the downstream end of the existing twin 30

inch diameter culverts that extend underneath Highway 99. At the downstream end of the twin culverts, the culverts empty into the existing Hamm Creek ditch. For about 150 feet this ditch would be maintained as part of the project. However, at 150 feet a new channel for Hamm Creek would be created to the east of the ditch, and this new channel would extend about 800 feet in a northwesterly direction, and then about 975 feet in an easterly direction, and finally about 350 feet in a southeasterly direction before it empties into the Duwamish River (see figure 4). At the upstream portion of the new Hamm Creek channel, a sediment basin (or settling pond) would be built that would have a capacity of about 200 cubic yards. After project completion the Hamm Creek ditch would be abandoned or even partially filled in, and Hamm Creek would flow through the newly created channel. Except for the twin culverts underneath Highway 99, Hamm Creek would no longer flow through culverts but would be "daylighted" all the way to the Duwamish River.

The new channel alignment and cross section is constrained by available real estate within an irregularly shaped 6.2 acre parcel of land, and it is constrained by the location of existing high tension towers and power poles throughout the area. The vertical geometry of the new creek channel is determined by the upstream invert elevation (16.7 feet), and by a desire to maintain most of the channel at an elevation high enough to prevent tidal inundation (+12 feet mean lower low water). The vertical geometry is further constrained at a location near its mid-point to an elevation no higher than +13 feet (mllw) to accommodate some inflowing drainage culverts. The last 50 feet of the channel requires six 1 foot drop structures (logs or rocks) to bring the channel from an elevation of +6 feet mllw down to 0 feet mllw.

The new channel bottom width would generally have side slopes of 1 vertical to 3 horizontal, with a bottom channel width of 20 feet. Where channel constrictions are required to avoid power poles, the bottom width would be reduced to 10 feet and the side slopes (on the power pole side) would be increased to 1 vertical to 1.5 horizontal. Where banks would be steep, then rock would be placed on the side slopes to stabilize the banks. A low flow channel (about 1 foot deep and 8 feet wide) would be excavated in the bottom of the channel. Note that although figure 4 seems to indicate a straight channel, in fact the channel would be created to meander within the 6.2 acre parcel. The estimated capacity of the channel would be about 150 cfs, at least equivalent to the capacity of the existing creek channel. A detailed evaluation of the hydraulic design is included in Appendix J.

An approximately one acre, fresh water, wetland would be created on the west side of Hamm Creek near the new creek outlet (see figure 4). Trees and shrubs would be planted along the edge of the excavated pond. Two smaller ponds would be excavated at the northwestern corner of the project site, also creating about one acre of fresh water wetland. An approximately one acre, intertidal, estuarine marsh would be created along the Duwamish River by excavating to elevation +9 feet (see figure 4).

Construction of the new channel would require the excavation of about 54,000 cy of material from the channel proper, 4,000 cy to create the fresh water ponds, and 5,000 cy to create the intertidal area. Excavated material would be hauled away to a suitable designated land fill area.

6.1.2 Vegetation plantings.

There are four different areas that would receive plants. All plants chosen would be native to the area. First, trees and shrubs would be planted along the newly created Hamm Creek channel near the top of the slopes in the vicinity of power lines. In order not to interfere with the lines, plants would be chosen from the following list: Indian plum, western crabapple, red flowering currant, red osier or Pacific dogwood, Oregon grape, salal, snowberry, Nootka rose, and Pacific or Hooker's willow. Second, trees and shrubs would be planted along the Hamm Creek channel where there would be no interference with power lines. In this area many of the above species could be chosen, and in addition the following trees would be planted: western red cedar, red alder, and shore pine. Third, in the estuarine marsh area along the Duwamish River, plants would be chosen from the following list: (from elevation 8.5 to 11.0) Carex lyngbyei and soft stem bullrush; and (from elevation 11.0 to 12.5) Douglas aster, Pacific silver weed, and Deschamsia caespitosa. Fourth, in the fresh water forested wetland area, trees and shrubs would be chosen from the following list: red alder, Sitka spruce, western red cedar, Pacific or Hooker's willow, red flowering currant, and red osier dogwood.

6.1.3 Construction timing, equipment, and techniques.

Construction details would be developed in the next project phase, plans and specifications. The following general information would most likely hold true. The new Hamm Creek channel would be built "in the dry" by using the existing Hamm Creek ditch to convey Hamm Creek water until the very end of the construction project. The new Hamm Creek channel would be built with excavators and bulldozers, and dump trucks would transport excavated material to a suitable upland disposal area. In a few areas the bank slope would have to be steep, and rock protected banks would be built in those areas (see figure 4). After the new channel has been completed, then the low flow channel would be excavated, and logs would be added to the channel to serve as drop structures. The intertidal, estuarine marsh area and the lower Hamm Creek channel near the Duwamish River would be built so as not to adversely impact fish which use the Duwamish River. Work near the river would not take place from March 15 through June 15, and would be coordinated with the Washington State Dept. of Fish and Wildlife and in accordance with treaty fishing activities. The large pond near the outlet of Hamm Creek and the two smaller ponds at the northwest corner of the 6.2 acre parcel could be built at almost anytime during construction. The last construction items would be the planting of all vegetation and the conveyance of Hamm Creek water to the new channel.

Construction activity will be confined to the 6.2 acre parcel itself, and an approximate 3.5 acre work and staging area which is interior to the 6.2 acre parcel (see shaded area in

figure 4). The 3.5 acre area would not be needed for the project at the end of project completion.

If possible all, or almost all, of the construction activity should take place in the relatively dry period from April through October. If this can be accomplished, then equipment would have less of a chance to get stuck in mud in either the 6.2 acre parcel or the adjacent work area. However, given that this potential project is eventually approved and funded, it is impossible to tell at this point precisely when construction would take place. Construction may have to take place partially during the wet season, and it is also possible that construction would have to occur over portions of two consecutive dry seasons. As will be shown in Section 8, the present best estimate is that construction would occur between May and September of 1999.

6.1.4 Operation and Maintenance

The sponsor, King County, would be solely responsible for the operation and maintenance of the habitat restoration project. Periodically the County would be expected to clean out the sediment basin on the new Hamm Creek channel, and replace dead trees, missing rock, and moved logs as appropriate. The average annual operation and maintenance cost is presently estimated at $3,000.

6.1.5 Biological and Physical Monitoring.

The purpose of the monitoring will be to determine if the goals and objectives of the project have been met, as well as to learn more about habitat restoration projects in general, i.e. what works and what doesn't work. This will help the Corps of Engineers and others to fine tune future restoration projects. This will not be a detailed research approach to monitoring, but rather a monitoring of a few of the project attributes. Specifically, an "as-built" survey would be completed after construction, and monitoring would be conducted in years one, three, and five. The cost for each year would be an estimated $15,000. In order to leverage limited funds, the monitoring would be coordinated with the agencies that are currently monitoring the nearby Coastal America and other restoration projects in the Duwamish Waterway. A report would be generated at the end of each monitoring.

The approach to monitoring would be similar to the project baseline evaluation contained in the "Results from the Pre-Restoration Biological Monitoring of Hamm Creek, Duwamish Waterway, Seattle, Washington", which is appendix B of this report. In year one, three, and five the following would occur: juvenile fish would be electroshocked, vegetative cover would be mapped, benthic invertebrates would be taken by core sampler, and insects would be taken by fallout traps. In year three and five, fish stomach contents would be analyzed at the same time that the benthic invertebrate and fallout insect sampling would be conducted to determine if the local fish are feeding on prey produced at the site. All sampling protocol would be comparable with those found in "Estuarine Habitat Assessment Protocols" developed for the Puget Sound Estuary Program. A

detailed monitoring plan will be developed during the plans and specifications phase of the project.

Physical monitoring will include the above mentioned "as built" survey to be conducted upon completion of construction. Additionally, three years after construction completion the Corps would survey Hamm Creek cross sections every five hundred feet (four total) as well as three separate sediment samples to be taken for grain size analysis. Grain size analysis evaluation will be conducted to evaluate sedimentation rates within the project.

6.1.6 Construction cost estimate.

The total construction cost in October 1997 prices is estimated to be $1,770,000 , which includes a 25% contingency. In addition to this cost, the real estate estimate is $821,000, the planning engineering and design cost is $390,000, the construction management cost is $170,000, and the monitoring cost is $45,000. The total project cost estimate is $3,196,000. Appendix E is the official government cost estimate.

It should be noted that the planning, engineering, and design cost mentioned above ($390,000) includes the feasibility level cost ($200,000) and the plans and specifications level cost ($190,000). The feasibility phase is the present study phase, and the plans and specifications phase is the next phase.

It should also be noted that the project is estimated to be completed in 1999. The 1999 cost estimate is known as the fully funded cost estimate. The figures for the fully funded cost estimate are: total construction ($1,864,000), real estate ($857,000), planning, engineering, and design ($398,000), construction management ($181,000), and monitoring ($53,000), for a total cost of $3,353,000. Appendix E shows a breakdown of the project cost in both October 1997 prices and the fully funded amounts.

6.1.7 Plans and Specifications

Assuming that the feasibility phase for this Section 1135 study is successfully completed and the Ecosystem Restoration Report (ERR) is accepted by Corps higher authority, then the study would be authorized for implementation and the project would proceed into the plans and specifications phase. Under this phase, the project details would be developed to such an extent that the project could now be completed by a contractor. Some of the items that are included under plans and specifications are completion of the final drawings, the detailed construction schedule, the final cost estimate, and the bid documents for the construction contracts. A value engineering study is planned for this phase; however, early discussions with the value engineer indicate that a VE waiver may be requested. Also within this phase is the signing of the Project Cooperation Agreement by the Corps and the County, and the certification of the necessary real estate. Early within this phase some additional project details will be examined, such as the exact placement and quantity

of logs and rocks in the new Hamm Creek channel, the hydraulic impacts of those logs and rocks, and what (if any) bank protection would be needed along the Duwamish Waterway in the vicinity of the estuarine marsh to be created.

6.2 ENVIRONMENTAL CONSEQUENCES

6.2.1 Biological Resources

There will be short term impacts from disturbance during the construction period. These short term impacts will be offset by the potential modifications and are expected to result in long-term, positive environmental impacts.

6.2.1.a Terrestrial Resources

Temporary adverse impacts will occur to terrestrial species, mainly noise and disturbance due to construction and human activity in the vicinity of the work area, and by a temporary loss of cover and habitat. This will occur during either one or at most two construction seasons. This impact would be minimized by using portions of the grassy field adjacent to the 6.2 acre site for temporary staging areas and work sites. This grassy field is not believed to be important habitat for any known terrestrial species. In the long-term, the increase in one acre of emergent estuarine marsh along the Duwamish Waterway should be of benefit to the following species: muskrat, waterfowl, and river otter. The newly created riparian habitat along Hamm Creek and the fresh water wetland habitat (the ponds) should be of benefit to frogs, salamanders, passerine birds, waterfowl, hawks voles, opossum, and raccoon. Best management practices such as construction during the dry season and the use of silt screens when working near the existing ditch should reduce the overall adverse impacts.

As a result of the project as proposed, specifically the interspersion of a variety of newly planted vegetation types such as forested wetlands, riparian buffer and emergent wetlands, many passerine birds will directly benefit from this. As a result of the vegetation plantings both cover and food resources will improve for the site. Newly planted trees will also allow for additional nesting sites.

The site will be more conducive to use by raptors especially as the planted trees mature. Perching sites and prey resource base are expected to increase over the existing conditions.

6.2.1.b Wetlands

Less than 1/3 of an acre of low value palustrine, non-adjacent wetlands are proposed to be filled as a result of this project. Under this proposal about three acres of wetlands (1 acre estuarine and 2 acres of high quality fresh water marsh) will be created. There may be short term temporary impacts to small wetlands (wet meadows) within the grassy field

adjacent to the site; however, these wetlands have relatively low value to fish and wildlife in comparison to the benefits of the completed project. Best management practices will be used to minimize these impacts.

6.2.1.c Prime Farmlands

The potential project would have no impact on prime farmlands.

6.2.1.d Aquatic Resources

There may be some temporary adverse impacts to aquatic resources during the construction period as heavy equipment in the area may cause an increase in turbidity in the Hamm Creek ditch. However, the new Hamm Creek channel would be created "in the dry" and the existing ditch which carries Hamm Creek water now would be relatively undisturbed until the new channel is completed. After channel completion, Hamm Creek would be diverted into the new channel. Through this method of channel construction Hamm Creek turbidity should be minimized. There will be a short term impact due to loss of benthic dwelling species as the newly constructed stream bed acquires a new fauna. This will be minimized as sediments from the old ditch bed are spread into the new creek to "inoculate" it with resident benthic species.

In the long-term aquatic resources would benefit from project construction. Fish passage for coho salmon, steelhead trout, cutthroat trout, and any other fish species which might use Hamm Creek would improve throughout the length of the project. The new Hamm Creek channel would recreate a more natural, meandering channel, and would provide fish with resting areas to improve their chance of swimming through the creek. At the lower end of the creek the project would create the most dramatic improvement for fish passage. Under existing conditions, fish that attempt to enter the Hamm Creek channel must first swim through a 1,900 foot culvert. With the project this culvert would be eliminated and replaced with a natural, open, meandering creek channel with a very gentle slope (never any greater than 2%) that leads to the Duwamish Waterway.

The addition of trees and shrubs along the Hamm Creek channel for about 2,300 linear feet would also improve fish habitat by providing shade which lowers water temperatures that benefits salmon and trout, and by providing a source of food for fish (i.e. insects drop from the leaves into the creek and are eaten by fish).

The creation of estuarine habitat along the Duwamish Waterway should result in the colonization of emergent vegetation (such as carex) that will be provide habitat for insects and other invertebrates. Studies have suggested that the new estuarine habitat would provide forage and refuge habitat for juvenile salmon and other fish. For example, monitoring of an estuarine channel created in 1993 in the lower Duwamish Waterway has shown that large numbers of juvenile sculpins, shiner perch, and juvenile salmon use the area.

The newly constructed site is also expected to improve the habitat quality for resident and migratory aquatic birds in the immediate area of Turning Basin #3. Diverse species such as common merganser, western grebe and spotted sandpiper should all profit from the newly created habitat. An increase in cover and sources of food from the existing condition can be expected. Additionally, trees planted along the bankline of the Duwamish as a result of this project will reduce the amount of disturbance these species currently experience.

6.2.2 Air Quality

The project would have very minor short-term impacts on air quality from the use of heavy equipment during the construction period. However, there should be no significant increase in emissions from construction vehicles during this period which would noticeably change the ambient air quality. Should dust become a problem at the construction site, then the contractor would be required to sprinkle dirt haul roads with water. There would be no long term impact on air quality from project construction.

6.2.3 Cultural Resources

As explained in Section 3.2.4, since no important cultural resources (either historic or prehistoric) have been found on the site, then no impacts to cultural resources would be expected. In the unlikely event that artifacts are discovered on the site during construction, then work would stop and notice would be given to the Office of Archeology and Historic Preservation. In the event human remains are discovered, then notice would be given to the King County Medical Examiner's Office. Affected Tribes will also be notified of the finding of artifacts or human remains.

6.2.4 Aesthetics and Recreational Resources

The 6.2 acre site and the surrounding grassy field receives relatively little recreational use now, and since this land is private property, any recreational use is not authorized. So even during the construction period there should be very little or no adverse impacts to recreation use. During the construction period there would be short-term adverse impacts to aesthetics from the construction equipment working within the 6.2 acre site and from material and equipment stored within the staging area in the adjacent grassy field.

In the long-term there would be significant gains in aesthetics from the project. After project completion and the establishment of mature riparian vegetation, Hamm Creek would once again be a more natural, meandering, tree-lined creek throughout the 6.2 acre site. However, the land would probably remain off limits to authorized recreation use.

6.2.5 Hydrology and Water Quality

As previously stated, short-term turbidity within Hamm Creek from construction activity would be relatively minor because construction of the new Hamm Creek channel would

occur "in the dry." Also, use of best management practices, designated through the Nationwide Permit Program, would minimize turbidity created by the project.

In the long-term the hydrology of Hamm Creek would be very similar to what it is today and the chance of overbank flooding along the creek (a rare occurrence) would be unchanged. The water quality would expected to be better for the salmon and trout that depend on the stream.

6.2.6 Threatened and Endangered Species

This section combined with the existing environment section (Section 3.2.7) constitute the biological assessment for this project.

Bald eagles (*Haliaeetus leucocephalus*) are year round residents in Elliott Bay, which is down river approximately seven miles from the project site at Duwamish Head. A nest is located in the cottonwoods in this area, and at least two young have fledged from that nest over the past three years. Both adult and sub adult are occasionally seen in the lower Duwamish Estuary. Additionally, about five miles down river from the project site is a hunting perch that bald eagle occasionally use. The perch is located in a cottonwood tree in the upland portion of Kellogg Island on the east side of the river. An eagle occasionally also perches on the piling located on the east side of Kellogg Island as well. Other documented eagle use areas in the West Seattle area are at Lincoln and Seward Parks, which are located several miles from the project site. No documented roost or nest sites are present on the 6.2 acre project site or directly adjacent to the site.

Food sources for these birds are typically waterbirds and fish, and these are seasonally abundant in the area. Eagles acquire food by hunting, scavenging and stealing from other species such as gulls and sealions. During the nesting season the primary diet is fish but this may change in the winter as more marine birds such as grebes, gulls and gilemonts move into the Duwamish estuary.

The work to be done at the Turning Basin #3 site is several miles from the nearest perch site (Kellogg Island area). The Turning Basin #3 project site contains no large trees suitable for perching although there are several large electrical transmission towers on the project site. There is a transformer station located adjacent to the project on City Light property. As described in Section 3, the area around the project site is heavily industrialized.

Based on the assessment of impacts, it is determined that the proposed project is not likely to adversely affect bald eagles.

Also, species of concern that may occur in the project area included bull trout and river lamprey. Sampling was conducted at the site during the spring of 1997, and bull trout and river lamprey were not present.

As stated previously (section 3.2.7) chinook salmon have been proposed for listing under the Endangered Species Act. We supplied this draft report to the local National Marine Fisheries Service office that has jurisdiction for chinook. They provided a letter (dated 3-3-98, Appendix G) that supported the proposed restoration efforts. During the plans and specification phase, additional informal coordination will occur and a biological assessment for chinook will be prepared. ? (NOTE: ADD'L BA WAS PREPARED)

6.2.7 Environmental Justice

This project would comply with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The project is located close to a low income and minority population area, and the residents of this area will have an opportunity to enjoy the natural amenities of this habitat restoration project.

6.2.8 Hazardous, Toxic, and Radioactive Waste

No evidence of hazardous, toxic, or radioactive waste material that has the potential to contaminate the groundwater, surface water, or soils in the project vicinity has been found, nor is there any reason to suspect its presence.

6.2.9 Cumulative Impacts

Cumulative impacts are assessed by evaluating the incremental effects of past, present, and future actions. Since the 1980's there have been several efforts to restore and improve habitat in the lower Duwamish River estuary. For example, volunteers have worked to improve Hamm Creek within the 6.2 acre site, a Coastal America project was completed near the 6.2 acre site in 1994, and a King County/"I'm a Pal" habitat restoration project was recently completed just to the west of the 6.2 acre site. The cumulative impact of these projects, others in the lower basin, and the potential Section 1135 project is to increase the biological health of the lower Duwamish River estuary.

6.3 COMPLIANCE WITH ENVIRONMENTAL STATUTES

It is the intent of the Corps of Engineers to comply with all regulatory and environmental statutes. The following table describes what permits need to be obtained. Most of the permitting work will be accomplished during the plans and specifications phase.

Permit Type	Issuing Agency	Who will obtain
Section 404 Clean Water Act	Corps	Corps
Section 401 Clean Water Act	Wash. St. Department of Ecology	Corps
Hydraulics Permit Approval	Wash. St. Dept. of Fish and Wildlife	King Co. (local sponsor)
Shorelines (includes Coastal Zone Consistency)	King County	King Co.
National Environmental Policy Act	Corps	Contained within this document
Historic Preservation Act	State Historic Preservation Office.	Completed. A project description was provided to the SHPO and after 30 days no response was received which is how concurrence is accomplished in the State of Washington.
Fill and Grade Permit	King Co.	King Co.
NPDES construction Permit	EPA	Corps

6.4 PUBLIC AND AGENCY COORDINATION

In compliance with NEPA and other pertinent laws and statutes, other agencies have already supplied the Corps with important information which was used in the making of this draft report and environmental assessment.

- The U.S. Fish and Wildlife Service provided the Corps with a list of threatened and endangered species that may use the potential project area. In addition the Service provided a Fish and Wildlife Coordination Act Report that provided information on a wide variety of topics.
- The State Historical Preservation Office has been contacted and we received no comment back. This is an indication that there are no known significant cultural sites in the project vicinity.
- Several letters of agency support for the potential project have been sent to the Seattle District Corps of Engineers, and these letters are included in Appendix G.
- The National Marine Fisheries Service stated that the chinook salmon has been proposed for listing under the Endangered Species Act.

This project has had extensive coordination with many groups since it was originally conceived in the late 1980's. Although the project name has changed several times (e.g. other names have been the City Light North Project and the Hamm Creek Restoration Project), and the conceptual design has changed, the basic premise of the potential project

has not changed. It is to provide additional estuarine habitat while "daylighting" Hamm Creek through the newly created estuarine habitat. This idea has been discussed at many local meetings in the nearby South Park neighborhood by such groups as the "I'm a Pal" Foundation, the Green/Duwamish Watershed Alliance, and the Elliott Bay Natural Resource Damage Assessment Habitat Technical Committee. The Technical Committee has been particularly important as a forum for discussing this project. The Committee, with representatives from National Marine Fisheries Service, U.S. Fish and Wildlife Service, the Muckleshoot Indian Tribe, the Suquamish Indian Tribe, the state Department of Fish and Wildlife, the state Department of Ecology, King County, and the City of Seattle, meets about once every two weeks to discuss projects, studies, and concerns of mutual interest. A habitat restoration project at the Turning Basin #3 site has been discussed off and on for the past 5 years, and many valuable study and project ideas have been developed by this committee.

To further solicit public and agency involvement and comment on this potential restoration project, the draft ERR (which includes the Environmental Assessment) was circulated to the Tribes and Agencies listed in the Table in Appendix G for thirty days. About half the agencies and Tribes responded. Many of the comments supplied by the reviewers have been incorporated in this report. These comment letters are also included in appendix G.

A few substantive comments were received in response to the tribal and agency review. They include:

1. The local sponsor (King Co.) in discusion with State Fish and Wildlife thought that the vault at the upstream portion of the project was not needed for this project. That change has been made and the vault has been removed from the design.
2. U.S. Fish and Wildlife wanted to have the point made clearer that at low tide fish cannot swim from the Duwamish to Hamm Creek. The outfall of Hamm Creek is inaccessible to fish at low tide. That clarification has been incorporated into this report.
3. National Marine Fisheries Service requested we include mention of some habitat improvement projects that are expected to occur in the proximity of the Turning Basin #3 project. A brief overview of these projects are included in section 4.1.

Many of the remaining comments were minor in nature or editorial in nature. Almost all of these comments have been included in the revised report.

6.5 SUMMARY OF REAL ESTATE REQUIREMENTS AND REAL ESTATE COST ESTIMATE

The proposed project modification encompasses approximately 6.2 acres of permanent easement and 3.5 acres of temporary construction easement. Seattle City Light is the property owner, and the non-Federal sponsor (King County) is now in the process of acquiring the real estate interests. The non-Federal sponsor has been advised of the risks associated with advance land acquisition activities. Before advertisement for construction, the non-Federal sponsor will make all lands necessary for the project available to the Federal government by a Certification of Lands and Authorization for Entry Document

(See Exhibit B of Appendix K), and Attorney's Certificate (Exhibit C). Following authorization for entry, the non-Federal sponsor will provide the Corps of Engineers, Seattle District, with all supporting lands, easements, and rights-of-way credit documentation. See Appendix K (Real Estate) for additional real estate information. See Exhibit A of Appendix K for the assessment of the non-Federal sponsor's real estate acquisition capability.

Provided below is a baseline cost estimate in present dollars for the land value, non-Federal sponsor land acquisition expenses, and federal review and assistance costs.

Lands and Damages	
6.2 acres permanent easement	$659,000
3.5 acres temporary easement	50,000
Subtotal Lands	$709,000
Non-Federal Costs Incidental to Acquisition	$29,000
Federal Review and Assistance	8,300
Subtotal	$746,300
Contingency (10%)	75,000
Total	$821,300

6.6 CONCLUSIONS

An overall positive environmental influence with no significant adverse impacts is anticipated with the proposed action. Therefore, it has been determined the preparation of an environmental impact statement is not warranted. The District has prepared a Finding of No Significant Impact (FONSI) which can be found in Appendix F. It is difficult to determine what would be the physical project life of the habitat restoration project; however, with proper maintenance by the sponsor, King County, it is believed that the project life would be at least 50 years.

Section 7

Non-Federal Responsibilities

7.1 COST SHARING AND THE PROJECT COOPERATION AGREEMENT

As required by Section 1135 of Public Law 99-662, as amended, the non-Federal sponsor is required to contribute 25 percent of the total project modification costs. If the non-Federal sponsor's total contribution (including LERRD value) is less than its required cost share of the total project modification costs, then the non-Federal sponsor shall provide a cash contribution and/or allowable work-in-kind for whatever sum is required for the non-Federal sponsor to meet its required share for the total project modification cost. If the value of the required LERRD exceeds the non-Federal sponsor's share of the total project modification costs, the Government, subject to the availability of funds, shall reimburse the non-Federal sponsor for the excess amount after final accounting is complete.

Once the project is approved for construction and plans and specifications have been completed, the sponsor and the Seattle District of the Corps of Engineers would be required to sign a document called the Project Cooperation Agreement (PCA) before project construction could begin. This agreement spells out the responsibilities of the sponsor and the Corps for the construction project. The document contains 19 articles, and covers such topics as definitions (Article 1), obligations of the government and the non-federal sponsor (Article 2), lands, relocations, disposal areas (Article 3), credit for lands, relocations, and disposal areas (Article 4), method of payment (Article 6), dispute resolution (Article 7), operation, maintenance, and repair (Article 8), and several others. The sponsor has reviewed a draft of the PCA and has agreed by letter dated 25 June 1998 to enter into the agreement before project construction.

The project costs and non-Federal sponsor cost share contributions will be re-assessed once plans and specifications are completed prior to executing the PCA. A final determination of non-Federal contributions will be conducted during final accounting following project construction.

7.2 FINANCIAL ANALYSIS

King County, the non-Federal sponsor, is willing and able to share the costs of project implementation. The fully funded project cost for the proposed restoration project is estimated to be $3,353,000. Of this total, 75% ($2,515,000) would be Federally funded, and 25% ($838,000) would be funded by the sponsor. Almost all of the LERRD value is creditable toward the sponsor's 25% share. For the proposed Turning Basis Project, the fully funded LERRD value is estimated at $857,000. The sponsor does not receive credit for Corps review and administration costs, which have been estimated at $9,000. Subtracting this amount from the total LERRD value results in a creditable value of $848,000. Since the creditable LERRD value is greater than the sponsor's 25% share, then the Federal Government would have to reimburse the sponsor by $10,000. A summary of the costs was shown in Section 6.1.6, and a detailed cost estimate is provided in Appendix E.

King County already has the funds needed to buy the required property, and it plans to do that in August 1998.

A letter of intent from the local sponsor to sign the project cooperation agreement (PCA) has been received by the Corps and is included in Appendix G. There have been minor changes in the project cost estimates and cost-sharing since receipt of the letter of intent, however these do not materially affect the sponsor's financial capability to support the project. The letter supports the selected alternative as the preferred alternative for restoring habitat at the project site, the County understands the present project cost estimate, and the County understands the cost sharing requirements under Section 1135.

The County has adequately demonstrated their financial capability to provide the necessary cash (if required) and real estate for project construction. The sponsor is also aware of their obligation to perform any necessary operation, maintenance, and replacement over the life of the project.

Section 8

Schedule for accomplishments

A projected schedule has been developed based on the assumption that Federal and non-Federal funds will be available. The tentative schedule for project completion is as follows. (Note: ERR stands for Ecosystem Restoration Report, which is the feasibility report. HQUSACE is the Seattle District's higher Corps authority in Washington, D.C. PCA is the Project Cooperation Agreement that is to be signed by the Seattle District and the sponsor.)

Submit draft ERR to public and agencies for review	Mar 1998
Final ERR completed and sent to HQUSACE for review	July 1998
ERR and PCA approved by HQUSACE, copies of final ERR sent to those that received draft ERR	Aug 1998
Corps begins Plans and Specifications (P&S) phase	Sept 1998
District completes most of (P&S) work and requests permission from HQUSACE to sign PCA	Jan 1999
HQUSACE grants Seattle District permission to sign PCA and sponsor certifies that project land is available	Feb 1999
PCA is signed and District's Real Estate Division certifies that sponsor has sufficient interest in the land	Mar 1999
District advertises construction contract	Apr 1999
District awards construction contract	Apr 1999
Construction begins	May 1999
Construction completed	Sep 1999

Section 9

Findings, conclusions, and recommendations

9.1 FINDINGS AND CONCLUSIONS

This report documents the damages sustained by the environment from the results of the Corps' Seattle Harbor Project. Specifically, the dumping of dredged material over the years in the vicinity of the Turning Basin Number 3 site has eliminated important estuarine habitat and contributed to the degradation of Hamm Creek. As a result of this project, and in conjunction with other non-Federal projects along the Duwamish Waterway, the health of the Duwamish estuary has dramatically declined and the loss of fish and wildlife populations has been enormous.

Based on technical analyses and economic studies, the Federal Section 1135 project proposed in this report will restore 1 acre of important estuarine habitat, 2 acres of fresh water marsh, and restore much of the health of Hamm Creek, a creek that provides important salmon and trout runs.

The total project cost in present dollars, which includes the feasibility cost, the plans and specifications phase, the construction phase, all lands needed for the project, and the cost of monitoring the site at three different times is $3,196,000. . The non-Federal sponsor is responsible for 25% of this total or $799,000, and the Federal sponsor is responsible for 75% or $2,397,000. The fully funded total project cost is $3,353,000, and the sponsor's share would be $838,000 and the Federal share would be $2,515,000. The local sponsor, King County, supports the conclusions presented in this report, understands their cost sharing requirements, and intends to sign the Project Cooperation Agreement (PCA) as soon as they are authorized to sign with the Corps.

National Environmental Policy Act (NEPA) documentation required for implementation of the proposed actions, in the form of an integrated Environmental Assessment (EA) and a Finding of No Significant Impacts (FONSI), is included in this report.

9.2 RECOMMENDATIONS

I recommend that the habitat modification and improvement described in this report be approved and implemented. In my judgment, the proposed project is a justifiable expenditure of Federal funds.

J. Steven Foster, P.E.
Chief, Civil Projects &
Planning Branch

FIGURES

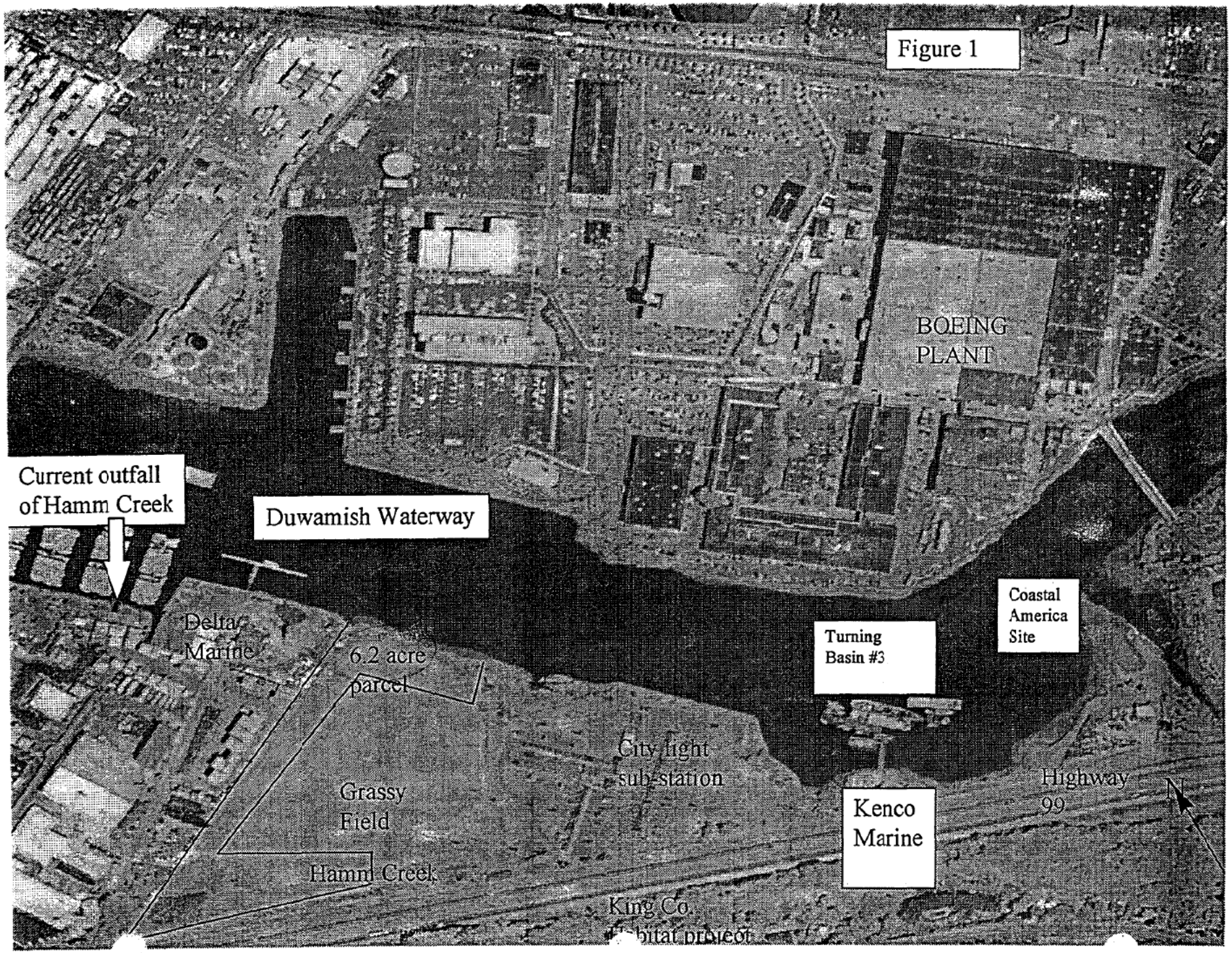
Figure 1
BOEING PLANT
Current outfall of Hamm Creek
Duwamish Waterway
Delta Marine
6.2 acre parcel
Turning Basin #3
Coastal America Site
City light sub-station
Grassy Field
Kenco Marine
Highway 99
Hamm Creek
King Co.