US Army Corps of Engineers ®
Alaska District

Chester Creek Aquatic Ecosystem Restoration Draft Report And Environmental Assessment Anchorage, Alaska

Chester Creek, Anchorage, Alaska

June 2004

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
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SECTION 206
ECOSYSTEM RESTORATION REPORT
AND
ENVIRONMENTAL ASSESSMENT
CHESTER CREEK
ANCHORAGE, ALASKA

June 2004

SUMMARY

The Alaska District, U.S. Army Corps of Engineers, and the Municipality of Anchorage (non-federal sponsor) are proposing to undertake an aquatic ecosystem restoration project on Chester Creek in Anchorage, Alaska. The proposed project is authorized under Section 206 of the Water Resources Development Act of 1996, P.L. 104-303. Section 206 authorizes the restoration of degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. The purpose of the restoration project is to improve passage for anadromous fish.

Urbanization, loss of streamside habitat, modification of spawning substrates, and most importantly, major obstructions to in-migration and out-migration access at the mouth of the creek have reduced the creek's salmon stocks almost to extinction. The current fish ladder at the lagoon severely hinders fish passage, allowing only a few fish to enter the creek each year.

For fish passage at Westchester Lagoon, a number of alternatives were considered including no action, removal of the dam/dike, construction of a fish ladder, construction of a flume, and construction of an open channel.

An environmental assessment (EA) supplementing the previous EA is integrated into this report. The previous EA did not address the plan recommended in this report. The recommended plan is to construct an open channel with a culvert under the railroad line to improve fish passage. Work would include relocating utilities, constructing a pedestrian bridge over the new open channel, relocating a portion of the bike trail, and disposing of the excavated material in Westchester Lagoon to create an island for an additional nesting and resting area for waterfowl common to Westchester Lagoon.

The recommended plan maximizes ecological benefits and accomplishes the project purpose, while minimizing costs and negative environmental consequences. Work would (1) increase the number of adult salmon that are able to enter the stream; and (2) increase the survivability of juvenile out-migrating salmon. The proposed work would increase the habitat units (HU) for coho salmon from 385 HU to 17,508 HU. All necessary permits will be obtained to ensure the project complies with water quality standards and avoids any unnecessary impacts to fish and wildlife.

The total estimated project cost is $6,530,000. The Corps' funding requirement is estimated at $4,846,000. The non-federal cost requirement is estimated at $1,684,000 after crediting of $136,000 for administrative and acquisition costs, and $1,583,000 for utility relocation.

It is recommended that the project be constructed with Federal participation.

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GLOSSARY

bioaccumulation. The process by which organisms absorb chemicals or elements directly from their environment.

biota. Organisms that occupy an ecological niche or ecosystem.

evapotranspiration. Loss of water by evaporation from the soil and transpiration (passage of water through plant into atmosphere) from plants.

fecal coliform bacteria. Aerobic (needing oxygen) bacteria found in the colon or feces, often used as indicators of fecal contamination of water supplies.

herbaceous annuals. Refers to a plant that has a non-woody stem and which dies back at the end of the growing season.

hummocky. Uneven.

hydrograph. A graph showing the stage, flow, velocity, or other property of water with respect to time.

hyperosmotic. Describes a cell or other membrane-bound object which has a higher concentration of solutes than its surroundings. For example, a cell which has a higher salt concentration than the salt concentration of the surrounding medium is hyperosmotic. Water is more likely to move into the cell through osmosis as a result.

impervious areas. Not allowing or passage through of water.

in-situ. In the natural or original position.

interstitial spaces. Small, narrow spaces found in between grains of sand.

macroinvertebrates. An invertebrate animal (animal without a backbone) large enough to be seen without magnification.

morphology. The form and structure of an organism or part of an organism; the study of form and structure.

osmoregulation. The regulation of water potential in an organism. Over many years, different species have developed evolutionary adaptations in relation to their environment due to the fact that any organism will always ‘want’ to have an ideal water concentration in its cells.

riparian zone. Pertaining to the banks and other adjacent, terrestrial (as opposed to aquatic) environs of freshwater bodies, watercourses, and surface-emergent aquifers (e.g., springs, seeps, oases), whose imported waters provide soil moisture significantly in excess of that otherwise available through local precipitation.

riprap. Layer of large, durable materials (usually rocks; sometimes car bodies, broken concrete, etc.) used to protect a stream bank or lake shore from erosion; may also refer to the materials used.

shoofly. A temporary track laid on the ground or on cribwork at one side of a railroad line to permit trains to pass an obstruction in that line.

smoltification. Suite of physiological, morphological, biochemical and behavioral changes, including development of the silvery color of adults and a tolerance for seawater, that take place in salmon as they prepare to migrate downstream and enter the sea.

spalling. Fragments removed from rock or concrete due to weathering.

thalweg. The line of deepest water within the low flow channel of a stream.

1.0 INTRODUCTION: PURPOSE AND NEED FOR THE ACTION

1.1 Problem Description

Chester Creek once supported strong returns and viable spawning habitat for coho salmon and Dolly Varden char. Although not documented, it is likely that pink salmon once spawned in Chester Creek. Urbanization, loss of streamside habitat, modification of spawning substrates, and most importantly, major obstructions to in-migration and out-migration access at the mouth of the creek have reduced Chester Creek salmon stocks almost to extinction. The problem can be divided into two areas: the fish passage at Westchester Lagoon and the restoration proposed for the remainder of the watershed. Figure 1 shows project locations identified on the creek.

1.1.1 Fish Passage at Westchester Lagoon

The Alaska Railroad originally crossed Chester Creek and its entire tidal estuary with a wooden trestle. See figure 2. This trestle was replaced with an earthen fill in 1934 and a shorter trestle over Chester Creek. Figure 3 shows the conditions in 1950 of the tidal estuary of Chester Creek. The City of Anchorage constructed a dam on Chester Creek in 1970–71 to create a recreation pond (Westchester Lagoon) near the mouth of Chester Creek. The dam was constructed 150 feet upstream of the Alaska Railroad Corporation (ARRC) track embankment within the intertidal marsh at the creek mouth. The outlet structure of the dam consisted of a concrete weir with two 7-foot-diameter outlet pipes. These pipes extended to the ARRC right-of-way. A fish ladder was constructed along with the weir in an attempt to maintain salmon access to the creek. The ladder is a 6-foot-diameter corrugated metal pipe (CMP) connecting the outlet structure to the lake. The slope of this culvert is 10 percent and it is largely ineffective. In 1972 the ARRC replaced the trestle over Chester Creek with two 7-foot-diameter culverts under the railroad embankment. These culverts connected to the two dam outlet culverts and the creek channel between the dam and the railroad embankment was filled. Figures 4 and 5 show the concrete weir lagoon outlet and the outlet culverts that go under the railroad embankment

In 1972 the Anchorage Water and Wastewater Utility (AWWU) constructed a 30-inch-diameter force main sewer across the creek downstream of the railroad. To reduce construction costs the culverts under the railroad were extended and the force main was placed above the culverts. In 1976 a petroleum pipeline (now owned by Tesoro Alaska Petroleum Company) also was constructed in the fill over the culverts. A second 42-inch-diameter force main was constructed in 1984 by AWWU in the fill, and in 1998, a second petroleum pipeline (owned by Anchorage Fueling and Service Company (AFSC) was constructed. All four pipelines are buried in the fill over the creek culverts. AWWU also has a gravity sewer line west of the railroad embankment and west of the end of the creek culverts. An aerial view of the present conditions at Westchester Lagoon is shown in figure 6.

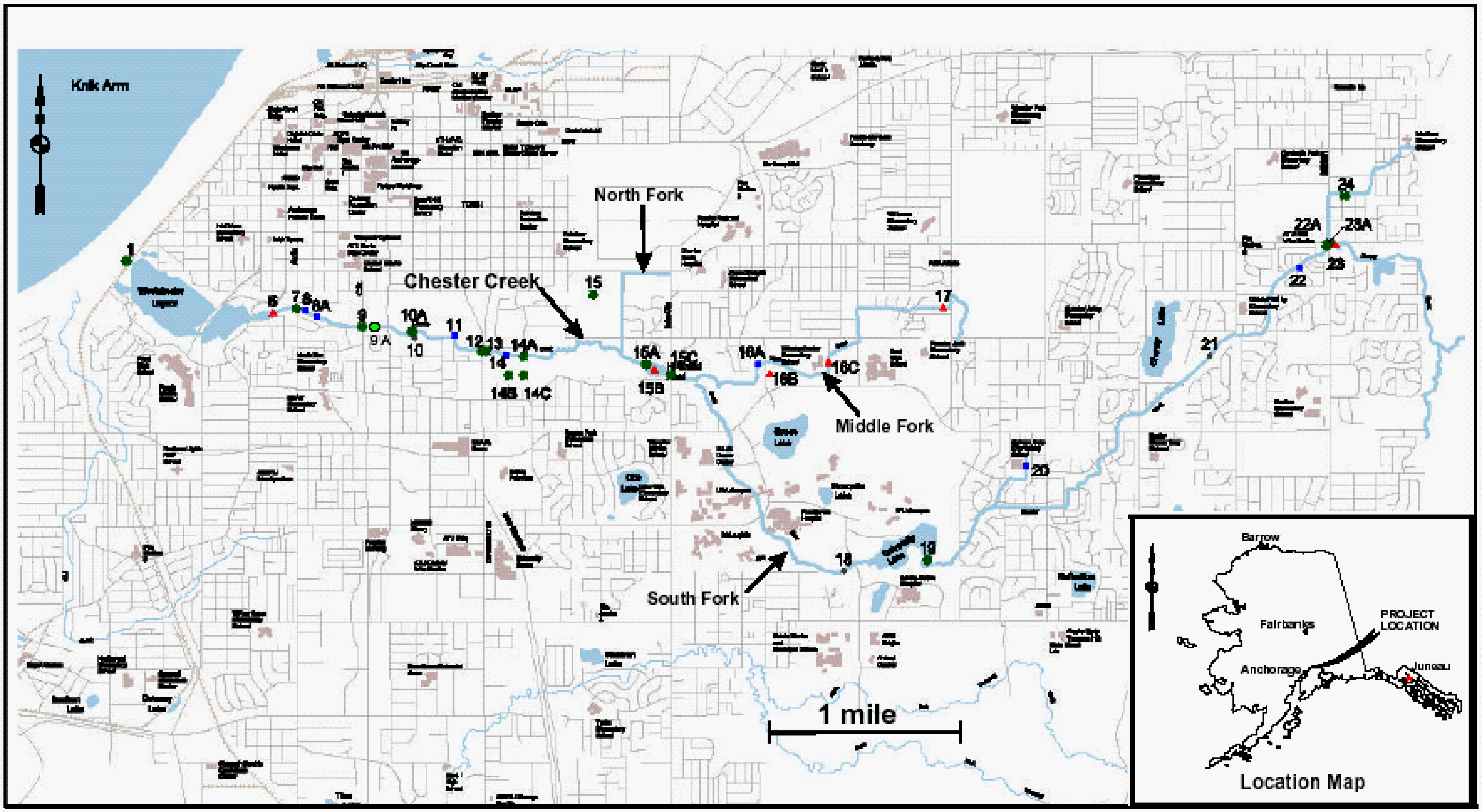

Figure 1. Location and vicinity maps with potential project sites along Chester Creek

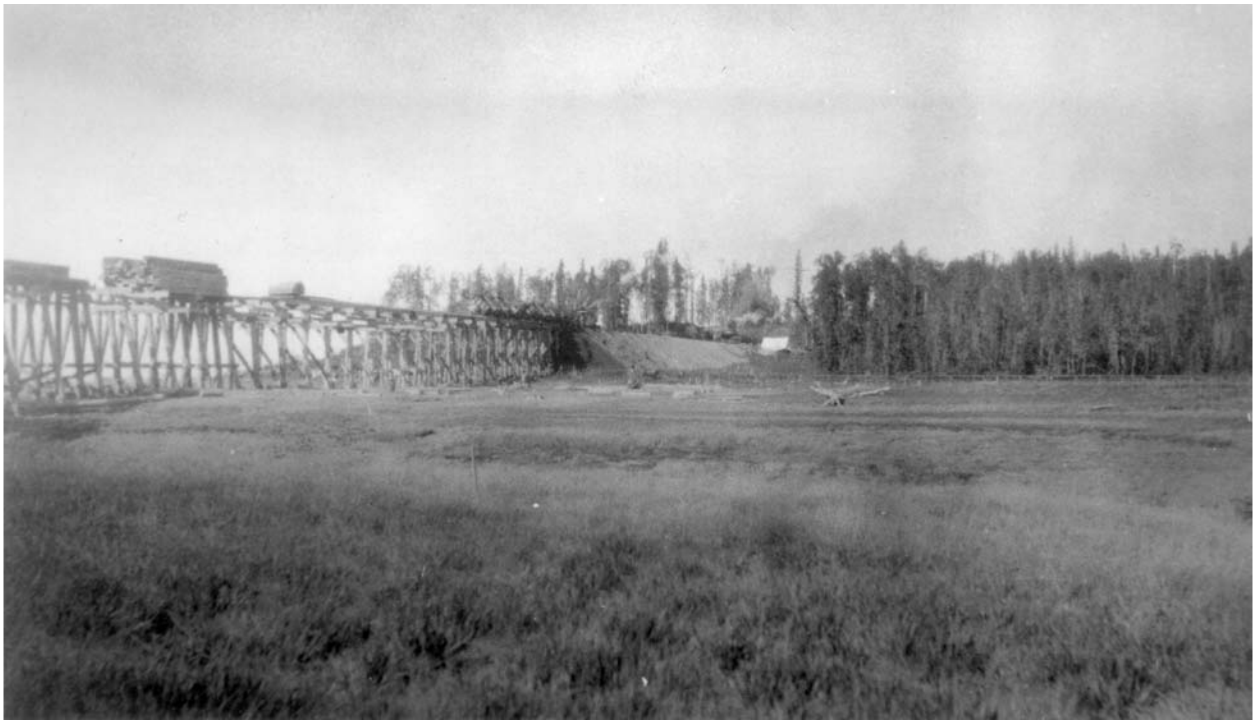

Figure 2. Photo of wooden trestle under construction near mouth of Chester Creek prior to 1934

Figure 3. Conditions at the mouth of Chester Creek in 1950

Figure 4. Westchester Lagoon outlet weir

Figure 5. Outlet culverts on Cook Inlet side of railroad embankment

Figure 6. Existing conditions at west end of Westchester Lagoon on Chester Creek.

Construction of the dam, railroad, and pipeline culverts impacted the available aquatic habitat in this portion of Chester Creek in several ways. The culverts and the inoperable fish ladder severely restricted fish passage between Cook Inlet and Chester Creek. Filling the channel also removed the opportunity for out-migrating salmon smolts and returning adults to become accustomed to salinity changes. Salmon mortality has probably increased without the adjustment period provided by the mixed salinity of the intertidal creek. Finally, the solid railroad fill and filled creek eliminated tidal flushing of the remnant estuary between the dam and the railroad fill. The elimination of tidal flooding caused a loss in species diversity and allowed colonization by less salt-tolerant 'weedy' plant species. This in turn probably decreased bird use and diversity.

1.1.2 Restoration on the Remainder of the Creek

Urbanization is the conversion of lands to impervious surfaces where the primary uses are commercial and residential in nature. Physical effects of urbanization include modification of hydrologic regimes, changes to riparian zone vegetation, loss of streams, reconfiguring of stream channels by construction of levees, and modification of water quality. The net result of these changes is simplification of aquatic habitat caused by the loss of large woody debris, loss of pool habitat, changes in substrate composition, and changes in channel shape and configuration. The Chester Creek stream corridor has undergone significant and deleterious impacts that have reduced or eliminated its natural functions. Specifically construction near or in the stream corridor has caused channelization, impounding or constriction of the channel, loss of riparian vegetation, and the alteration of wetlands associated with the stream corridor.

Urban streams are often badly eroded. Many are wider and shallower than their counterparts in undeveloped watersheds, and they are often devoid of large woody debris and lack significant pools. Long reaches of uninterrupted riffles are common, interstitial spaces among the bed gravels are generally packed with silts and sands, often to great depths, and the flow regime—the pattern of season high and low flows—is profoundly altered. Water temperatures tend to be higher and pollution episodes—especially turbidity—are more frequent and longer lasting. In response to these effects, the biota of urban streams is often impoverished. Macroinvertebrates, such as mollusks and aquatic insects, are often the first to respond. Their diversity tends to be lower in urban than in non-urban systems. The less tolerant among them, the freshwater mussels, the stoneflies, mayflies, and many species of caddis flies, are replaced by groups with greater tolerance for degraded conditions. Among fishes, anadromous species such as coho tend to be lost first, followed by resident trout and some species of sculpins. In extreme situations, some streams have become virtually lifeless.

A mature forest will evapotranspire on the order of 40 percent of annual rainfall (Chow, 1994). In lowland streams most of the rest of annual precipitation infiltrates and becomes groundwater. It can take months or years for groundwater to reach streams. In a natural state, only a small fraction of precipitation reaches the stream in less than a day. Under forested conditions, peak flows are low and of short duration, and refuge habitat is plentiful. Streams are cool and clean, shaded by a biologically complex riparian zone, spawning gravel is open and unsilted, and groundwater feeds the stream all summer. Under these conditions fish thrive.

Urbanization changes all that. A primary link between urbanization and the demise of habitat is excessive runoff. With mathematical models it has been shown that in a built-up condition in the watershed, peak flow events in the stream can increase in magnitude five to ten times the peaks seen in a pristine state. Groundwater flows in summer months that used to keep steams viable can go to zero.

1.2 Study Authority

This Ecosystem Restoration Report is authorized under Section 206 of the Water Resources Development Act (WRDA) of 1996, P.L. 104-303. Section 206 authorizes the restoration of degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Restoration involves consideration of the ecosystem's natural integrity, productivity, stability, and biological diversity. The Alaska District prepared the Preliminary Restoration Plan (PRP) in July 1999 to evaluate alternatives to restore Chester Creek in Anchorage, Alaska. An environmental assessment (EA) was prepared in June 2001 to comply with the National Environmental Policy Act (NEPA) and to solicit public review. A Finding of No Significant Impact (FONSI) was signed on 19 November 2001. The EA prepared in 2001 presented the big picture of the restoration effort and provided an opportunity for public comment. The restoration project was divided into two tasks; restoring fish passage at Westchester Lagoon and the restoration of the remainder of the creek.

This document integrates the EA and includes supplemental information to revise the original EA. A new FONSI was also prepared. This document focuses on fish passage at Westchester Lagoon. It is essential that this be the first priority because it is the limiting factor for salmon access to the creek and therefore any upstream improvements would not benefit the fish if their access remained blocked at the mouth. Further restoration will be the subject of future documents.

1.3 Need for Change

Society, government organizations, and political leaders are becoming increasingly aware of how land-use practices are altering stream channel processes and impacting the associated fisheries resources. The concept of urban salmon habitat has certain emotional appeal. The reality of urban streams is they have become storm sewers, and those that are currently fish bearing streams, such as Chester Creek, may soon exhibit classic symptoms of storm sewer morphology. Probably the most important solution to the restoration of Chester Creek involves combining development and sound engineering principles to minimize the impact of human interference in the natural watershed process. Habitat for wild fish is not an engineering problem, and we should guard against shifting the burden of responsibility for its protection from its rightful place as a social issue to a technical one.

However, engineering can play a role in habitat protection and recovery of Chester Creek. It can provide a means to retain and regain a semblance of natural, pre-development watershed conditions. There are formidable obstacles: (1) The creek corridor is not of sufficient width to allow the stream to freely migrate; (2) the watershed hydrology exhibits extreme peaks and valleys; and (3) sedimentation through storm sewer input and local runoff have impacted water quality. The Chester Creek Restoration working group developed both general and specific restoration opportunities that would aid in the improvement of the aquatic ecosystem in several categories.

It is important to understand that Chester Creek can never be fully restored to a pre-development condition. The hydrologic characteristics of the watershed have been permanently altered and development would not allow for the creek to meander along the entire reach.

While the original appearance has been lost, it is possible to restore much of Chester Creek's natural function. Although it flows through an urban area, the creek could once again support a viable anadromous fish population. The entire ecosystem could benefit from improvements in habitat and water quality.

1.4 Scope of Study

The original PRP presented approximately 50 restoration projects along Chester Creek. Upon further review and analysis, the scope of the study was narrowed down to one high priority project that is critical to the restoration of the creek. The primary project is to enhance fish passage at the mouth of the creek at Westchester Lagoon. Major project features include fish passage through a railroad embankment, creation of an intertidal channel and access to Westchester Lagoon. Feasible alternatives were identified and evaluated, and the best plan was selected based upon likelihood for success, cost, ecological benefits, community support, and engineering design.

1.5 Study Participants

The Alaska District, U.S. Army Corps of Engineers has the primary responsibility for this study. The Municipality of Anchorage is the local sponsor. The Alaska Railroad Corporation (ARRC) has been integral to the success of the study. The U.S. Fish and Wildlife Service (FWS), Alaska Department of Natural Resources, Anchorage Waste Water Utility, Anchorage Waterways Council, Signature Flight Support, and Tesoro Alaska Petroleum Company have also contributed to this study and its success.

1.6 Related Reports and Studies

- "Westchester Lagoon Offsite Mitigation Plan For Municipality of Anchorage, Parks & Recreation Department and Olympic, Inc., Anchorage, Alaska" dated May 1985 was prepared as a requirement of a Department of the Army Section 404 Clean Water Act permit (4-84026).
- "Progress Report, Urban Contaminants Project: Data for Sediment, Fish and Eggs Collected from Chester Creek, Anchorage, Alaska 1991" dated April 1994, was prepared by the U.S. Fish and Wildlife Service, Ecological Services, Anchorage.
- "Fish Passage Improvements for Westchester Lagoon" dated October 1996, was prepared by HDR Alaska, Inc. for the Municipality of Anchorage.
- "Chester Creek Aquatic Habitat Evaluation, Anchorage Loop Water Transmission Main Project" dated December 1997, was prepared by Northern Ecological Services for Montgomery Watson.
- "Technical Report No. 01-7, Chester Creek Stream Condition Evaluation" dated July 2001, was prepared by the Alaska Department of Fish and Game.
- "Chester Creek 206 Study, Aquatic Habitat Restoration Project Final Report" dated December 2000, was prepared by HDR Alaska, Inc. for the U.S. Army Corps of Engineers.
- "Chester Creek Aquatic Habitat Restoration, Westchester Lagoon Improvements, Design Study Report Draft" dated December 2001, was prepared by HDR Alaska, Inc. for the Municipality of Anchorage.
- "Aquatic Ecosystem Restoration Chester Creek, Anchorage, Alaska. Environmental Assessment and Finding of No Significant Impact" dated June 2001, was prepared by the U.S. Army Corps of Engineers, Alaska District.
- "Conformity analysis for the Section 206 Aquatic Ecosystem Restoration Project Chester Creek, U.S. Army Engineer District, Alaska, Project Number PWII63533" prepared by HDR Alaska, Inc. July 2002.

2.0 AFFECTED ENVIRONMENT: DESCRIPTION OF STUDY AREA

2.1 Project Location

Chester Creek runs through Anchorage, Alaska, which is in the south-central portion of the state. Chester Creek originates in the Chugach Mountains and passes through a highly urbanized watershed before draining into Cook Inlet (figure 1). Restoration on the creek for this project would occur in the lower portion of the creek at the west end of Westchester Lagoon where it drains into Cook Inlet.

2.2 Community Profile

Anchorage is the largest city in Alaska with a population of about 260,000. The Municipality of Anchorage encompasses 1,697 square miles of land and 263 square miles of water. Anchorage is the center of commerce for the state. Oil and gas industries, finance and real estate, transportation, communications, and government agencies are headquartered in Anchorage. Numerous visitors and tourist facilities and services are available. Over 9,000 military personnel are stationed at Fort Richardson Army Post and Elmendorf Air Force Base (Alaska Community Database).

2.3 Climate and Air Quality

The Anchorage area is in the transitional zone between the extremes of the continental and the maritime climatic regimes. Winds generally are not severe; however, localized channeling effects brought about by topographic features result in greatly accelerated speeds (80+ mph). The Anchorage bowl receives from 13 to 20 inches of precipitation annually. Precipitation as rainfall occurs from about mid-April to about mid-October. Heaviest precipitation is in July and August, with about 70 inches of snow falling during the winter months. The yearly average high temperature is 42.6 °F, with a yearly average low of 29 °F.

Most of the Anchorage bowl is designated as a non-attainment area for carbon monoxide, to include the project site. The Clean Air Act and Amendments of 1990 define a "nonattainment area" as a locality where air pollution levels persistently exceed National Ambient Air Quality Standards. The primary cause is vehicle emissions during winter months. Dust from road sanding and open, non-vegetated areas also have an effect on area air quality.

2.4 Geology

The Chester Creek watershed can be classified into three general deposits.

Silt and clay deposited in still water: former lakes and ponds in lowlands, ancestral marine estuaries, former ice dammed lakes near the mountains, and the present tidal zone in upper Cook Inlet. The mouth of Chester Creek is typical of stream and river mouths in upper Cook Inlet.

Sand and gravel deposited mainly by streams in front of glaciers (glacial outwash), along stream channels (modern and abandoned), along mountain fronts (alluvial fans), and in lakes or estuaries (deltas). The deposits are generally well layered and well sorted and are chiefly gravel in the eastern part of the lowlands toward the mountains, grading westward into sand deposits. They are commonly covered with a thin veneer of silt.

Mixed coarse-fine-grained deposits-till: a poorly sorted material of mixed origin; for example, glacial, marine, and lake deposits, including elongated hills known as drumlins. The poorly sorted material may include boulders, gravel, sand, silt, and clay.

2.5 Hydrology

Chester Creek starts in the Chugach Mountains and drains about 30 square miles above Westchester Lagoon. About 50 percent of the basin is urbanized. The creek has three major forks: North Fork, Middle Fork, and South Fork. South Fork is the longest. It originates in the Chugach Mountains and drains the undeveloped area east of Muldoon Road. East of Muldoon Road, South Fork splits into a north and south branch. West of Muldoon Road, the South Fork has been channelized, straightened, and lowered to its intersection with the main stem. The Middle Fork originates at Russian Jack with several sections routed through storm sewers. The North Fork now originates in the closed Merrill Field landfill and has been channelized for most of its length.

There are three impoundments within the Chester Creek basin: University Lake, Hillstrand Pond, and Westchester Lagoon. The dominant land-use category in the basin is single-family housing. The lower portion of Chester Creek runs through a dedicated greenbelt.

Average annual runoff from the Chester Creek basin is about 9 inches. Although annual runoff from the mostly undeveloped upper part of the basin is about equal to that from the urbanized lower part, differences in monthly runoff are evident. During snowmelt periods, runoff is higher at Arctic Boulevard near the mouth of Chester Creek than at the undeveloped south branch of the South Fork. These differences are probably due to runoff from impervious areas between the two areas and because snowmelt does not occur in the upland areas east of Muldoon Road until late May or June. Only minor differences in runoff are observed during fall and winter periods, while differences in summer runoff vary depending on the distribution of rainfall. During storm events, water reaches the creek faster in the lower portion of the drainage since paved surfaces and storm drains convey water more quickly compared with undeveloped areas. The hydrologic cycle in undeveloped areas returns runoff to the creek at a much slower rate. In undeveloped areas, precipitation is affected by increased evapotranspiration and absorption into the soil.

Differences in both magnitude and character of flow are apparent from inspection of discharge hydrographs for the south branch of the South Fork and at Arctic Boulevard. Mean daily flows at the former station (south branch, South Fork) range from 4 to 16 cubic feet per second (ft^3/s); the smooth hydrograph and relatively subdued peaks reflect runoff from the undisturbed terrain in the headwaters of the Chester Creek basin. At Arctic Boulevard mean daily discharges from this much larger drainage area range from 15 to 60 ft^3/s; the short, sharp peaks (i.e., rapid rise and fall of the hydrograph trace) at this point on the creek reflect runoff from paved areas and other impervious surfaces (Brabets 1987).

2.6 Water Quality

In general, the source of a particular water-quality constituent may be classified as either "point" or "non-point" source. An example of a point source would be the outlet into a stream of a municipal sewerage system or of an onsite septic system. The "point" of origin of these constituents may be easily observed and identified. A non-point source consists of constituents derived from a broader area such as the entire drainage basin or an extensive residential or commercial development. The origin of a particular water-quality constituent from a non-point source is not easy to identify or control.

Chester Creek is listed on the Alaska Department of Environmental Conservation's Section 303(d) list of water quality-limited water bodies. It is listed primarily for fecal coliform bacteria, but other pollutant sources include urban and industrial runoff, and septic tanks.

There is little or no runoff from urbanized areas during base-flow periods. During periods of rainfall and subsequent runoff, particulates from the urbanized areas enter Chester Creek causing an increase in sediment, nutrients, and other constituents. The same types of constituents are washed into the stream by runoff during snowmelt periods (approximately from the first part of March to the end of April).

In winter, traction sand is pre-wet with liquid magnesium chloride to cause the sand to stick better to the road. Pre-wetting the traction sand is more effective and reduces the amount of sand needed. At some intersections and under certain conditions, liquid magnesium chloride is used for anti-icing instead of sand. Anti-icing is a procedure where liquid magnesium chloride is applied to the road in advance of precipitation to prevent ice build-up by lowering the freezing point of the solution. It should be noted that the magnesium chloride that is used is significantly less corrosive than salt. Anti-icing helps keep the snow mushy, providing better traction during the beginning of a snow event.

Brabets' (1987) work on the quantity and quality of urban runoff of Chester Creek came to the following summary and conclusions:

1. Urbanization has changed the flow characteristics of Chester Creek. Peak discharges (expressed as cubic feet per second per square mile) are two to three times higher in the developed part of the basin than in the undeveloped part of the basin.
2. With the exception of fecal coliform bacteria levels, water in Chester Creek at base-flow conditions meets State of Alaska drinking water standards. Rainfall-runoff periods show increased concentrations of suspended sediment, certain trace metals, nutrients, and fecal coliform bacteria. However, the highest concentrations of these constituents are found during snowmelt periods. Non-point sources account for most of these increased concentrations.
3. Fecal coliform bacteria concentrations near the mouth of Chester Creek exceed State of Alaska standards during all levels of flow. Lead concentrations exceed State standards during rainfall-runoff and snowmelt periods. Chloride concentrations exceed State standards during snowmelt periods.
4. Concentrations of trace metals are directly related to concentrations of suspended sediment and thus are likely to be absorbed into the sediment. Analyses of bed-material samples taken along the course of Chester Creek indicate that certain trace metals are being deposited in the streambed.
5. Annual loads of chloride and sodium transported from the Chester Creek basin range from 394 to 635 tons chloride, and 214 to 342 tons sodium. These loads depend on the amount of yearly snowfall. Approximately 680 tons of suspended sediment is transported from the Chester Creek basin. Most of the sediment originates from the urban part of the basin.

6. Analysis of surface-water data from areas with three distinct land uses in the Chester Creek basin showed that "drainage area, storm rainfall, and the percentage of effective impervious areas are significant variables in determining runoff volumes and peak discharges."
7. Analysis of water-quality data from the three land-use bites indicates that the primary source of dissolved constituents, trace metals, and suspended sediment originates from commercial areas. The primary source of nutrients and fecal coliform bacteria is from residential areas.

2.7 Vegetation and Wetlands

The following habitats are found in the Chester Creek watershed.

Coastal Marsh. Coastal marshes are found along the shore of Cook Inlet and are influenced by the rise and fall of the tides. The shoreline on the Cook Inlet side of the railroad at the mouth of Chester Creek is typical of coastal marshes found elsewhere in Knik Arm. Fresh water flows into Cook Inlet through Chester Creek and dilutes the salinity of the water. Coastal marshes include salt marshes and tide flats. Salt marshes consist of nearly level, poorly drained, bluish-gray, clayey tidal sediment. Although the areas are a few feet above the level of the average tides, they are inundated occasionally by exceptionally high tides and by the overflow from Chester Creek. Vegetation consists primarily of lyngbye sedge, marine arrowgrass, alkali grass, and plantain. Higher areas may also contain a sparse to dense vegetative cover of bluegrass, silverweed, and bluejoint grass. Shrub thickets may occur along the highest shoreward areas, which are still subjected to regular, short duration inundation by high tides. These thickets generally contain little other vegetation except for algae. However, sparse stands of beach wild rye and sedges may grow on the flats. The tidal flats consist of layered tidal deposits ranging from sand to clay in texture. The lagoon side of the railroad is not tidally influenced and the vegetation is not exposed to saltwater.

Riparian. Riparian wetlands are temporarily flooded areas along rivers, creeks, and streams (floodplains). The associated vegetation is determined by the elevation above the stream, and the duration and frequency of flooding. Some temporarily flooded areas are characterized by a mixture of broad-leaved shrubs, such as willow and alder, with emergent vegetation dominated by grasses. Other common understory vegetation may include marsh fivefinger, nagoonberry, red currant, and prickly rose. Some wetter riparian areas dominating the lower elevations may contain most of the following: sweet gale, tufted clubrush, bladderworts, cottongrass, buckbean, sundew, livid sedge, rotund sedge, maritime arrowgrass, bog cranberry, bog blueberry, cloudberry, bog willow, bog rosemary, and various mosses. Seasonally flooded areas adjacent to Chester Creek consist of a shrub complex dominated by black spruce, with willow and alder the dominant shrub type. Deciduous trees such as black cottonwood and balsam poplar may dominate drier, higher elevation areas. The typical shrubby willow and alder may reach tree size in some localities. The substrate is usually a mineral soil, while some poorly drained, wetter areas in lower elevations may consist of organic or peat soil.

Forested Bog. These areas are commonly called black spruce bogs. The dominant canopy species is black spruce that reaches a height of at least 20 feet. Dominant understory vegetation of the forest includes Labrador tea, low bush cranberry, horsetail, cloudberry, and sphagnum moss. The understory vegetation may also be shrubby black spruce (less than 20 feet). In wetter areas there may be a layer of emergent vegetation. Some temporarily flooded areas with open canopies of evergreens may accommodate broad-leaved deciduous shrub vegetation. Black cottonwood and balsam poplar may also be mixed with stands of black and white spruce. The substrate may be hummocky from frost heaves, with standing water occurring between the heaves. In this case, the spruce grows on the hummocks with emergent vegetation and mosses between. The forested bogs may occur at the fringe, higher elevated areas of shrub bogs, or as "islands" in shrub bogs.

Shrub Bog. Shrub bogs are located on saturated, organic soils (peat). They are commonly called black spruce bogs when the dominant vegetation is shrubby black spruce (less than 20 feet). The difference between the shrub black spruce bog and the forested black spruce bog is the height of the spruce. In shrub bogs dominated by black spruce, canopies may be open with a dense deciduous shrub understory. In areas not dominated by shrubby black spruce, canopy species consist of broad-leaved deciduous shrubs such as willow, sweet gale, thin-leaf alder, dwarf birch, Labrador tea, bog blueberry, low bush cranberry, and bog rosemary. The saturated peaty soils are usually covered with a mat of sphagnum moss. The bogs may be composed of bog ridges and islands, with wet hollows between. The ridges are generally oriented perpendicular to water movement within the bog. Broad-leaved deciduous shrubs including dwarf birch, Labrador tea, bog rosemary, sweet gale, and shrubby black spruce dominate the ridges and islands. The wetter, lower areas between the ridges and islands are typically dominated by emergent vegetation such as grasses, sedges, horsetail, and cottongrass, and are usually semi-permanently flooded. Small ponds may exist in the bog, and are irregularly sized, spaced, and shaped. Larger ponds, if present, may contain peat islands.

Open Water/Emergent Marsh. Open water/emergent marsh wetlands encompass open freshwater areas such as lakes and ponds, the fringes of marsh surrounding the lakes and ponds, and any expanses of freshwater wetlands dominated by emergent vegetation. The lakes and ponds are permanently or seasonally flooded. Vegetation in deeper open water may be lacking, with aquatic beds of vegetation and emergent plants along the shoreline. The predominant aquatic, floating-leaved plants are yellow pond lily and pondweed. Some of the seasonally flooded small ponds contain water only during the growing season. When surface water is absent, exposed substrate either remains unvegetated or is colonized with herbaceous annuals. Mud and sand flats along the lakeshores are typically devoid of vegetation. If vegetated, the shoreline vegetation may consist of species such as sphagnum moss, great bulrush and other sedges, grasses, bladderwort, buckbean, marsh five-finger, horsetail, and sweet gale. Emergent marshes may be permanently or seasonally flooded. Permanently flooded, emergent marshes exhibit standing water throughout the entire year. The dominant vegetation is buckbean, horsetail, bladderwort, grasses, and sedges. Seasonally flooded marshes usually exhibit water for part of the growing season. Species include horsetail, sedges, marsh five-finger, and sphagnum moss. Willow shrubs may occur as sparse cover. Westchester Lagoon and the marsh between the lagoon and the railroad embankment are examples of open water/emergent marsh wetlands.

2.8 Fish and Wildlife

Fish. Chester Creek formerly supported good runs of coho salmon and Dolly Varden char. The coho salmon spawned in all the tributaries throughout the drainage. Dolly Varden were also found throughout the watershed, and although not documented, Chester Creek probably supported a run of pink salmon. Rainbow trout are an introduced species and are periodically restocked by the Alaska Department of Fish and Game.

It is thought that about 10 coho salmon now return to Chester Creek. Currently, coho salmon are the least abundant fish species in Chester Creek, whereas they were the most abundant in the early 1970s. The coho population density (including juveniles) in Chester Creek was estimated at 34 per stream mile in 2001 compared to 217 in 1974 (Davis and Muhlberg, 2001).

Juvenile coho salmon spend the first 2 years of life in the riverine environment prior to migrating to the ocean. Consequently, adequate cover, cool water, and sufficient food to sustain them through their fry and juvenile stages become critical habitat components. Juveniles are normally found in relatively slow currents and prefer water temperatures within the range of 40 to 48 °F.

Emergent coho fry require shallow, quiet areas, usually associated with backwater pools and dammed pools. They are also found in side channels and along the quiet water margins of other types of habitats. In periods of high flows and cold water temperatures, juvenile coho shift to slow, deep pools, beaver ponds, or to side channels and backwater pools of the main stream. Under these conditions, the young fish are dormant and seek cover under rocks, tree roots, logs, debris, and in logjams.

During summer, preferred habitats are primary pools or backwater eddies in association with an undercut bank, submerged tree roots, or branches and logs. During the summer the young coho require cool water temperatures. Stream canopy should be approximately 80 percent to maintain suitable water temperatures.

Salmon also require an estuarine area to adjust from saltwater to fresh when migrating upstream to spawn, and an area for smolts to acclimate during out-migration (osmoregulation). Under current conditions on Chester Creek, fish do not have an area to acclimate to changes in salinity. This reduces reproductive success of adults and the survivability of out-migrating smolts.

Wildlife. All species of terrestrial animals that occur in the Anchorage Bowl can be found in the Chester Creek stream corridor. Big game species include moose, black bear, and the occasional grizzly bear. Urban wildlife species include non-game birds and small mammals.

Wildlife use is a product of the greenbelt and the lack of development along the creek on the military reservation (headwaters area). While the available area for wildlife habitat improvement is too small to have an appreciable affect on wildlife, the greenbelt serves as an excellent corridor for wildlife.

Birds. The greenbelt along Chester Creek is home to a wide variety of birds. These birds are common to the Anchorage area and are not unique to Chester Creek. Common waterfowl include mallards, green-winged teal, American wigeon, scaup, and lesser Canada geese, which typically inhabit the lagoon areas near the mouth of the creek. Mallards, gulls, Canada geese, and grebes also nest at Westchester Lagoon. The existing wetlands downstream of Westchester lagoon are very small and provide limited nesting habitat for waterfowl. Pedestrians who stray from the coastal trail to view the wetlands compromise nesting waterfowl by disturbing nesting birds. Numerous other birds are common in the Chester Creek area to include ravens, chickadees, finches, sparrows, magpies, woodpeckers, and waxwings.

2.9 Threatened and Endangered Species

Congress enacted the Endangered Species Act (16 USC 1531 et seq.) (ESA) in 1973. The FWS and the National Marine Fisheries Service (NMFS) administer the act. The ESA provides for the conservation of species that are at risk of endangerment or extinction throughout all or a significant portion of their range and the conservation of the ecosystems on which they depend. The goals of the act are to provide a means to conserve the ecosystems upon which endangered and threatened species depend and to restore all Federally-listed endangered and threatened species to the point where their numbers again make them viable, self-sustaining members of their ecological communities. Federal agencies are required to consult with the FWS and NMFS when proposing a Federal action under Section 7 of the Act to avoid, minimize or mitigate the impacts of their activities on listed species or their critical habitat.

No threatened or endangered plant or animal species, or their critical habitat or candidate species are in the Chester Creek watershed. This has been coordinated with the FWS and NMFS and is included in appendix B.

2.10 Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act strengthened the ability of the NMFS and Fishery Management Councils to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat" (EFH) and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act requires the Fishery Management Councils to describe and identify the essential habitat for the managed species, minimize to the extent practicable adverse effects on EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH. Coho salmon and stocked rainbow trout are managed species within the Chester Creek watershed.

2.11 Socio-economic Resources

Chester Creek greenbelt is a highly used recreational corridor. Many people hike and ride bikes along the paved trail that parallels much of the lower reach of Chester Creek. In winter, ice-skating is a major attraction at Westchester Lagoon

2.12 Land Use and Ownership

The Municipality of Anchorage (MOA) and the State of Alaska own the majority of the land involved in the proposed project. The Alaska Railroad Corporation (ARRC) maintains a right-of-way where the rail line passes along the western portion of Westchester Lagoon. Easements would be obtained for the private lands that are involved in the project.

The ARRC has been contacted and would be kept informed on the progress of the proposed project. The MOA owns the land on either side of the ARRC right-of-way (ROW). The ARRC ROW is 200 feet wide through this area.

The MOA land on the east side of the ARRC ROW is dedicated parkland and managed by the Department of Parks and Beautification. This department has been contacted as part of this analysis, and they stated the proposed improvements are consistent with their management objectives for this property.

The ARRC has granted several easements in their ROW in this area. The MOA has easements from the ARRC for the coastal trail and AWWU's sewer force mains and gravity trunk. Tesoro and AFSC have been granted an easement from ARRC for their pipeline within the ARRC ROW.

Construction access for work on the east side of the railroad embankment would be through the Westchester Lagoon parking area at 15th Avenue and U Street. This access point would then use the coastal trail to access construction areas. This access would require temporary rerouting of coastal trail traffic and a Park Use Permit from the Department of Parks and Beautification.

Construction access for work on the west side of the railroad embankment would be from 12th Avenue and U Street. An access road to the AWWU pump station near the project area crosses the railroad at this intersection. Once at the pump station a temporary access road would need to be constructed across the coastal trail to the construction area. This would be the primary access for utility relocation and other work west of the railroad embankment. A temporary access permit would be required from the ARRC for the access road and the utility relocation work area. Crossing the coastal trail would require a Park Use Permit from the Department of Parks and Beautification.

A permanent easement would be required for the reconstructed creek through the ARRC ROW. The MOA would require this for channel maintenance after construction. The AWWU manhole access corridor appears constructible within the ARRC ROW, but additional easements may be required.

2.13 Archeological and Historical Resources

The State Historical Preservation Officer has been contacted regarding historical sites near Chester Creek. Three sites in the vicinity of Chester Creek are listed by the State of Alaska as archaeological/historical sites.

Site # ANC-361 KENI Radio Building (KENI radio station). A two story flat-roofed, cast concrete structure with a full basement. The basic shoebox shape is altered on the north by the center portion of the wall set at an angle. The building has a covered porch, large windows with wide rounded wooden frames, and a decorative tower on which the station’s call sign is sculpted in 2-foot tall letters. The building is an excellent example of Art Deco style in Anchorage. The building has been operating as a radio station since May 1948. It is one of the few commercial buildings from before 1950 in Anchorage.

Site # ANC-419. This site is located at 1219 U Street on Blueberry Hill. It is a one and one-half story modified Cape Cod-style frame structure built around 1940. Two complementary, lateral wings were added in the 1960s and 1970s.

Site # ANC-420 Bootlegger Cove Cabin. This low-profile cabin (which has saddled-notched corners and was built in two sections) was started in the early 1940s. During World War II, the soldiers stationed at the site used the unfinished cabin without making any improvements. After World War II, Bud Tout leased the land and finished the cabin.

Although there are several prehistoric sites throughout Anchorage, there are no known sites near Chester Creek. As stated in the correspondence with the SHPO, the SHPO would be contacted if any potential artifacts were discovered during construction.

2.14 Coastal Zone Consistency

Chester Creek is within the Municipality of Anchorage Coastal Management Program. The Municipality of Anchorage Coastal Management Program and Areas Which Merit Special Attention became effective for State, Federal and local implementation on June 22, 1981. The Municipality of Anchorage Wetlands Management Plan became effective in May 1982 and was revised on April 29, 1996.

3.0 PLAN FORMULATION

3.1 Planning Criteria

Development of this report and completion of the study was conducted in accordance with the appropriate guidance and regulations to include the following: Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983), Civil Works Ecosystem Restoration Policy (ER 1165-2-501, 30 September 1999), Ecosystem Restoration – Supporting Policy Information (EP 1165-2-502, 30 September 1999), and Planning Guidance Notebook (ER 1105-2-100, 22 April 2000).

3.1.1 Ecosystem Restoration Objective

The objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. This involves consideration of the ecosystem's natural integrity, productivity, stability, and biological diversity. The need for improving or re-establishing both the structural components and the functions of the natural area have been examined.

3.1.2 Ecosystem Restoration Justification and Cost Effectiveness

An ecosystem restoration project is justified when the combined monetary and non-monetary benefits of the project exceed its monetary and non-monetary costs. Units of output have been defined, benefits specified, and cost of production evaluated. Alternative plans as discussed below have been evaluated, to include consideration of alternative methods and sizes.

3.1.3 Net Ecosystem Restoration Benefits

The recommended plan should be the justified alternative and scale having the maximum excess of monetary and non-monetary beneficial effects over monetary and non-monetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is worth the extra costs. This plan should be called the National Ecosystem Restoration (NER) plan and is discussed in section 4.0.

3.2 Scoping/Public Participation

Chester Creek flows through areas encompassed by 10 of the MOA's 38 Community Councils. An initial presentation to introduce the project was made to the community councils within the Chester Creek watershed. Table 1 shows the community councils within the watershed, the day of the month they meet, and the contact used to schedule our presentation. Table 2 shows the date of each presentation and who made the presentation. A second project presentation will be made after publication of the final report. The initial presentations were between April 27, 2000, and June 8, 2000. A presentation was also made to the MOA Parks & Recreation Commission. Much of Chester Creek is within municipal parkland and this citizen's commission reviews projects within municipal parkland. All projects within municipal parks will have to be reviewed and approved by this commission.

Table 1. Chester Creek Community Councils, Meeting Dates, and Contacts

	Community Council	Meeting Date	Council Contact
1	South Addition	4th Thursday	earthscp@alaska.net
2	Spenard	1st Wednesday	authr@lanepowell.com
3	University Area	1st Wednesday	protec@alaska.net
4	Rogers Park	2nd Monday	bbutera@gci.net
5	Russian Jack Park	2nd Wednesday	kplunkett@rexdata.com
6	Fairview	2nd Thursday	Lowe_Geraldine@msmail.asd.k12.ak.us
7	Airport Heights	3d Thursday	sdickey@alaskalife.net
8	North East (Muldoon)	3d Thursday	ddgarret@alaska.net
9	North Star	4th Wednesday	mensch@alaska.net
10	Scenic Park	4th Thursday	wrtheuer@alaska.net

Table 2. Presentation Dates and Presenters

Community Council	Date	Presenter
South Addition	Thursday, April 27	Dan Billman
Spenard	Wednesday, May 3	Dan Billman
University Area	Wednesday, May 3	Robin Reich
Rogers Park	Monday, May 8	Dan Billman
Russian Jack Park	Wednesday, May 10	Dan Billman
Parks & Recreation Commission	Thursday, May 11	Dan Billman
Fairview	Thursday, June 8	Dan Billman
Airport Heights	Thursday, May 18	Robin Reich
North East (Muldoon)	Thursday, May 18	Dan Billman
North Star	Wednesday, May 24	Dan Billman
Scenic Foothills	Wednesday, May 25	Dan Billman

The purpose of the presentations was to accomplish three goals: (1) announce that the study was underway, (2) describe what will be happening during the study, and (3) solicit input from people attending the meeting. To meet these goals, presentation flip charts were used that covered the project name, location map, project history, current and future work, and project contacts. Key points of the study were highlighted to stay within the short timeframe of the presentation. The audience was asked to describe any potential creek work within their community council area for the project team to evaluate. Ideas were taken from the floor and comment sheets were handed out for people to send in with additional comments or projects. The formal presentation ended by giving an overview of the types of projects being considered near that community council's area and with a discussion of the major projects considered for Westchester Lagoon. Presentations lasted about 15 to 30 minutes depending on the number of questions asked by the participants.

Most questions were to clarify points made during the presentation. Others focused on particular projects or potential work on the creek. Many were interested in the creek's habitat and water quality, and whether fish were able to live in the creek. Finally, many were interested in the Corps' 206 program and asked questions about how it worked.

During the question and answer period, a general discussion of the project would occur within the council group. These would last 5 minutes or more and generally revolved around peoples' experiences with or at the creek, or how the creek should be protected or improved. Without exception, the community councils agreed the creek was a valuable asset to the city and was worth protecting and improving. To the people attending the meetings, the creek offered many opportunities for both active and passive recreation. Improving the creek's aquatic habitat was viewed as important to maintaining the creek's value to these people and for the city. Throughout the presentations, people agreed this project was worthwhile and they endorsed its completion. All were interested in later detailed presentations about specific actions.

At each presentation some time was spent discussing interaction between salmon and the creek. Many people were surprised and delighted to hear there is still a small but viable run of silver salmon in the creek and that chum salmon were seen in 1999. Others reported living on the creek for over 40 years and told of strong runs of silver and even king salmon. Participants felt salmon were an important component in the creek and were excited to hear major work was being considered at the Westchester Lagoon dam to improve fish passage over this structure and through the railroad fill. They felt that even if salmon runs were improved, salmon fishing should not be allowed on the creek. They felt there were too many property and access conflicts, and the creek was too small to withstand increased angler pressure on its banks.

3.2.1 Public Concern

A number of public concerns have been identified during the course of the study. Additional input was received through coordination with the community councils along the creek, the sponsor, and some initial coordination with other agencies. Some community councils did have specific comments for the study team to consider. These are listed in table 3. The public concerns related to the establishment of planning objectives and planning constraints follow:

- Construction noise if major improvements were built at Westchester Lagoon outlet.
- Maintenance costs associated with the improvements.
- Increased public activity near railroad property, on coastal trail, in stream for fishing.
- Restore fish passage to a more natural state.
- Maintain the recreation opportunities provided by the Westchester Lagoon and the coastal trail.

Table 3. Specific Community Council Comments

Community Council	Specific Comment
South Addition	Concerns were expressed about construction noise if major improvements were built at Westchester Lagoon outlet.
Spenard	No specific comments.
University Area	No specific comments.
Rogers Park	A request was made to explore purchase of a parcel of land adjacent to the creek to maintain adequate buffer between the creek and residential development.
	Concerns were raised about the municipality being a partner and being responsible for increased maintenance costs on the creek after projects were constructed. The council requested that the report include the future operational costs associated with each project.
Russian Jack Park	No specific comments.
Parks & Recreation Commission	The commission asked to be part of the design review process.
Fairview	A request was made to consider clearing brush near the creek to increase public safety and reduce people camping in the greenbelt.
Airport Heights	Questions came up as to how the project may affect creek bank owner's property rights.
North East (Muldoon)	Several projects were suggested on the north branch of the South Fork of Chester Creek.
North Star	An idea was presented about moving storm drain outfalls back from the creek and creating treatment ponds or wetlands at the new pipe ends. These ponds could also be used as small pocket parks.
Scenic Foothills	The council was concerned about dog feces pollution in the creek and was interested in steps to educate dog owners and increase policing of trails for errant pet owners.

3.3 Restoration Needs, Problems, and Opportunities

The evaluation of public concerns often reflects a range of needs that are perceived by the public. This section describes these needs in the context of problems and opportunities that can be addressed through water and related land resource management.

A list of all potential restoration opportunities for Chester Creek was developed through a combination of community council meetings, resource agency meetings, and study team meetings. Approximately 50 restoration opportunities were identified throughout the watershed (see appendix G).

The Chester Creek Restoration Project, Section 206 Preliminary Restoration Plan (PRP) identified approximately 30 separate locations along Chester Creek and its branches for restoration projects.

Following field reconnaissance the PRP projects were ranked high, medium, or low priority or were eliminated. A high priority project was one that should be undertaken immediately upon the availability of funding. These were projects that greatly improved fish passage, reduced sediment, provided important habitat, or took advantage of an opportunity that may not be available in the future.

Medium priority projects were generally small in scale and lower in cost. These projects were likely candidates for completion even if the 206 matching funds were not available, potentially as mitigation for development in other areas.

Low priority projects were ones that required a large amount of work or funds to achieve the potential benefit. These projects could be undertaken with benefits occurring for habitat, but should be done only if other projects are completed first.

Some projects were eliminated from consideration. For example, some projects considered reconnecting relict portions of the streambed to existing reaches but were dropped from further consideration due to large changes in elevation between the current and former bed elevation.

The high priority projects were further ranked in order of their ability to contribute to the overall improvement of the Chester Creek aquatic ecosystem. These were categorized as access improvement, sediment reduction, or habitat improvement projects.

Access projects were considered of highest value because, if the fish do not have access, the habitat value is not important. Access projects were ranked in priority from downstream to upstream. Access projects were primarily focused towards resolving fish migration blockages at existing culverts.

Sediment reduction projects were considered the next highest value because other studies underway in Chester Creek indicate that reducing sediment in the creek may increase aquatic insect productivity. Increasing aquatic insects in the creek would increase the amount of food available for resident fish and juvenile salmonids. This would create a more robust creek ecosystem. Sediment reduction projects were ranked from downstream to upstream. Sediment reduction projects included sediment removal from storm water, and stabilizing eroding or damaged creek banks.

Habitat improvement projects were considered next. These were ranked by size from largest to smallest habitat improvement. Habitat improvement projects included maintaining riparian corridor continuity, restoration or creation of creek bank habitat, and increasing the diversity of in-stream habitat.

Upon further review and analysis, it was decided that attempting to complete all 50 projects under one study was too ambitious. Of highest priority were projects related to fish passage and habitat improvement. Based on the ranking procedure, two potential projects were identified that would be most applicable to accomplishing restoration goals. The first project is located at Westchester Lagoon and involves removal of a portion of the railroad embankment and construction of an intertidal channel to establish fish passage. The sponsor was already planning to construct the second project, which is to improve habitat by reducing sedimentation.

After ranking and evaluating the various opportunities, study team members narrowed the study down to the most important objective, improving fish passage at the mouth. This objective would provide the greatest improvement to the creek and is critical to its restoration.

3.3.1 Fish Passage at Westchester Lagoon

Problem Description. Establishing fish passage is considered the most important component of the restoration of Chester Creek. Without passage there would be little reason to perform upstream projects since few fish would access the stream to realize any benefit. Restoring fish passage is viewed as a priority by resource agencies involved in the project to include the Alaska Department of Fish and Game (ADF&G), FWS, and NMFS.

The existing fish ladder at Westchester Lagoon fails to correct a major obstacle to fish passage, and the few fish that do make it into the creek, probably do so by chance. The obstacles to fish passage include the following:

- Fish must enter one of two 84-inch-diameter culverts in Cook Inlet by locating the scent of freshwater.
- Culverts are only accessible when tidal elevations are between -4.1 and 3.9 feet mean sea level (MSL) since fish tend not to dive to locate the entrance.
- Migration is limited to an incoming tide since the length of the culvert and force of an outgoing tide prohibit fish passage. The weaker swimming pink salmon are unable to negotiate the passage regardless of tide stage.
- Upon entering the weir, fish must locate the entrance to the 72-inch-diameter fish ladder. The fish cannot use scent since the water coming down the fish ladder has the same scent as the water coming over the weir.
- Water that spills over the weir creates turbulent conditions at the entrance to the ladder.
- Once in the fish ladder, salmon must negotiate an 80-foot-long culvert at a 10 percent upslope grade to gain the 13 feet of elevation necessary to reach the water level of Westchester Lagoon.
- Smolts attempting to re-enter Cook Inlet experience an abrupt change in salinity since there is no transition zone where smolts can acclimate.

3.4 Planning Objectives

The national objectives of National Economic Development and National Ecosystem Restoration are general statements and not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities, and represent desired positive changes in the without-project conditions. The planning objectives are specified as follows:

- <u>To increased access to the creek by salmon</u>. The primary objective of the project is to reduce the hindrance(s) to fish passage described above. The objective of the project is to increase the ability of fish to migrate upstream to spawn, and increase channel conditions to increase the ability for smolts to survive the transition between freshwater in the stream and the saltwater in Cook Inlet. The design must incorporate appropriate criteria to include consideration of water depth, water velocity, and channel slope. The design must also take into account the extreme tidal fluctuations found in Anchorage (extreme range of 40.7 feet).

Of great importance is ensuring that a transition zone for fish to acclimate to changes in salinity is included in the design. When migratory salmonids enter saltwater, they are exposed to salt loading and water loss. The transition to a hyperosmotic solution results in several osmoregulatory, structural, morphological, and metabolic changes. For example, changes occur in the gills, esophagus, intestine, and kidney in order to accommodate the salt-water environment (Hogasen, 1998). The acclimatization generally takes place over several days or weeks, underscoring the need for an intertidal channel where salmonids can gradually adjust to differing salinity.

- Reduce property risk from flooding. Extensive fill and urban development have increased flows and flooding potential. Designs must not increase flood risks. The design must also take into account dam safety.
- Reduce maintenance costs. The MOA wants to ensure that improvements reduce long-term operation and maintenance costs. Structures like fish ladders typically require regular maintenance.

3.5 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this study are as follows:

- Keep project impacts to property owners low. The project site is in an urban area near residential homes. A bike trail, railroad track, and radio antennae border the project site. Impacts to adjacent property owners and local residents need to be minimized to the extent practicable. Public involvement has been used to ensure that local concerns are taken into consideration.
- Designs for fish passage will need to incorporate crossings for the bike path and the railroad tracks.
- Executive Order 11988 requires Federal agencies to evaluate the potential effects of actions on floodplains, and should not undertake actions that directly or indirectly induce growth in the floodplain, unless there is no practical alternative.

3.6 Measures to Address Identified Planning Objectives

A management measure is a feature or activity at a site that addresses one or more of the planning objectives. A wide variety of measures were considered, some of which were found to be infeasible due to technical, economic, or environmental constraints. Each measure was assessed, and a determination made, regarding whether it should be retained in the formulation of alternative plans. Descriptions of the measures considered in this study and the results of their evaluations are presented below:

3.6.1 No Action

The Corps is required to consider the option of "no action" as one of the alternatives to comply with the requirements of the National Environmental Policy Act (NEPA). No action assumes that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. No action, which is synonymous with the without-project condition, forms the basis from which all other alternative plans are measured. This alternative would leave conditions as is. Fish would continue to have to try and pass through the fish ladder. Potential benefits would not come to fruition. It is assumed that about 10 coho salmon a year would continue to access the stream. The culverts are currently in need of maintenance due to perforation by saltwater erosion.

3.6.2 Nonstructural

Trucking fish around the obstruction. Fish would be gathered as they accumulate near the existing inlets and outlets, and transferred around the dam. This alternative besides being very inefficient would not provide an area where out-migrating juvenile salmonids could acclimate to changes in salinity. Because the obstruction is at the mouth of the creek, manual transfer of the fish would cause an immediate transition and result in the mortality of many juvenile fish.

3.6.3 Structural

Removal of Westchester Lagoon Dam. The dam could be removed and the original creek channel could be recreated to pass under the railroad track. In other words, the creek could be restored back to its condition prior to 1972 when the lagoon was constructed. This alternative is not acceptable to the local sponsor or the community. Westchester Lagoon is a popular recreational area that is highly valued by the community. The bike trail around the lagoon and adjacent parkland is one of the most popular recreational areas in town. During the summer, residents and tourists use the area for roller bladeing, bicycling, canoeing, bird watching, and walking. During the winter months, snow is removed from part of the lagoon and an outdoor ice skating area is created. On weekends, several hundred people can be seen ice-skating at any one time. This measure was, therefore, eliminated from further consideration.

Fish Ladder. A number of alternatives have been considered in the past, that includes some type of fish ladder. In 1987, Corwin and Associates, Inc. evaluated five alternatives in their report "Chester Creek Water Quality Study and Improvement Investigation." All the alternatives discussed in the report included some sort of fishway (ladder). Design of a fish ladder at the site is problematic considering the physical restraints of the area to include tidal range, ice accumulation, elevation drop of about 21.3 feet between the lagoon and inlet, and the railroad tracks. Also of concern is providing an intertidal area for fish to acclimate to changes in salinity. The preferred alternative in the 1987 report was to construct a new fishway, a channel between the fish ladder and Cook Inlet, and a railroad trestle. The preferred alternative was not constructed due to limited funding.

Fish passage was again investigated in a 1993 study (Chester Creek 92-16, Conceptual Design Report prepared by HDR Engineering) and in an October 1996 study (Fish Passage Improvements for Westchester Lagoon prepared by HDR Alaska). These studies reevaluated the work done in the 1987 Corwin report and included a fish ladder. The recommended plans did improve fish passage, but they had drawbacks including substantial operation and maintenance requirements, and the lack of an intertidal channel for anadromous fish to acclimate to changes in salinity.

Flume. This plan approaches the fish passage problem differently from other studies, but still includes a fish ladder. This alternative entails constructing a new lagoon outlet to the south of the existing spillway. The design included a flume from the lagoon to the east side of the railroad tracks, a culvert tunnel under the tracks to carry the flume, and a fish ladder to connect the flume to the creek channel. The fish ladder would have been connected to the creek channel at the existing culvert end on the Cook Inlet side of the railroad tracks where underground utilities are located.

While the flume design addressed the inoperative fish ladder, it also had substantial design and maintenance concerns. Since the fish ladder was on the Cook Inlet side of the railroad tracks, the design would need to address the tidal range, ice accumulation, and wave action characteristic of Cook Inlet. These would be large forces, and the cost could increase greatly to prevent the structure from being damaged. Also, maintenance and operation costs would be high due to the ice and saltwater environment causing concrete spalling. As with the other fish ladder designs, this alternative did not provide an area where out-migrating juvenile salmonids could acclimate to changes in salinity. The flume would cause an immediate transition and result in the mortality of many juvenile fish.

Costs for this proposal are a minimum of $3 million; however, this estimate does not take into account the underground utilities, the costs of constructing a shoofly (a temporary track constructed around a work area), or halting train traffic during construction. The proposed tunnel design would not permit the construction of a railroad shoofly without significant modification. As a result of the design concerns, and in particular, the lack of a transition area between fresh and saltwater, this measure was eliminated from further consideration.

Intertidal Channel. This measure would involve creating a channel between Westchester Lagoon and Cook Inlet that passes underneath the railroad tracks. Of importance was considering designs that did not include a fish ladder and that provided a transition zone for fish to acclimate to changes in salinity.

<u>Channel Length</u>. The length of the channel was maximized to increase the amount of intertidal habitat, decrease the slope, and avoid the need for a fish ladder. The area between the existing railroad tracks and the lagoon is greatly limited. The channel design is also constrained by the existing bike trail and radio antennae tower. The elevation difference between the lagoon and the inlet is approximately 21.3 feet. For optimal fish passage, the slope should approach 1 percent. The minimum water depth should be 0.6 to 0.8 feet. Shortening the channel would not appreciably decrease project costs and would increase the slope, making it more difficult for fish to traverse the stream. Shortening the channel would also reduce the amount of intertidal area for fish to acclimate to changes in salinity. To minimize the channel slope, the longest channel distance was selected allowing for a pool and riffle construction, which in turn will create many places for fish to hold during the tidal cycle. In addition, having a gradual slope reduces the riprap size requirements and associated costs.

<u>Crossing the Railroad Track</u>. Previous studies (Corwin and Associates 1987, and HDR Alaska 1996) considered different methods of passing under the railroad track embankment. Work to install a culvert large enough to accommodate the creek would be similar to that of constructing a trestle. Train traffic would have to be suspended during periods of work or a shoofly constructed. Soils in the area are of poor quality, necessitating the installation of substantial bedding material. There is also the issue of designing the culvert to accommodate the slope, while still letting fish pass through without the need for a fishway. The Oregon Department of Fish and Wildlife Guidelines and Criteria for Stream-Road Crossings state "gradients (slope) for non-embedded, non-baffled culverts shall not exceed 0.5% unless a tailwater situation exists to backwater the culvert to a suitable depth for its length. Properly baffled or weired culverts are appropriate for steeper gradients depending on design. Structures with fishways (i.e., fish ladders or culverts with weir-type baffles) generally will be required where culvert gradients exceed 5% and streambed simulation is not employed."

Environmentally, bridges are preferred over culverts. Bridges leave the streambed functional, productive, and intact. They typically provide larger openings to accommodate extreme flooding events, and they provide more light to the streambed. Bridges also rarely inhibit fish passage due to water velocities for smaller fish as culverts often do if not designed and installed properly. The ability of a fish to pass through a culvert varies directly with the culvert's diameter and inversely with culvert length and water velocity.

3.7 Ecosystem Restoration Alternatives

3.7.1 Conclusions from the Preliminary Screening

Preliminary plans comprise one or more management measures that survived the initial screening. Preliminary screening indicates that alternatives that use an intertidal channel for fish passage, which provides a transition zone for fish to acclimate to changes in salinity, have the greatest potential for meeting the planning objectives identified earlier in this report. Two alternatives were further evaluated and are described in the following section. Costs associated with the two alternatives are shown in table 7.

3.7.2 Alternatives Considered

Open Intertidal Channel with Trestle (Alternative 1). This alternative would provide the most natural function and appearance to the mouth of Chester Creek and is supported by local resource agencies. Chester Creek originally had a lengthy intertidal reach; however, this area was lost in the early 1970s when Westchester Lagoon was created. While the new intertidal section would be substantially shorter, the natural function would be restored to the system to a far greater degree than any other alternative considered.

Creating an intertidal channel would affect vegetation between the lagoon and the tracks. Increased salinity in the area would affect species composition; salt intolerant plants would die out and be replaced by more salt tolerant species. The small trees and shrubs within the area would die. The pond at the far southwest end would likely become fringed by tall sedge (grass-like) and herb species (*Scirpus* species, *Carex lyngbyaei*, *Hippurus tetraphylla*) that root in the water but extend up to a foot or two above the pond surface. These grass-like plants would also colonize other areas that pool water as the tide ebbs. The broad area northwest of that pond is now dominated by tall grass species that tolerates flooding well but probably cannot withstand a higher salt input. Much of the central part of the area is dry; most of its plants would die when flooded. This area likely would become dominated by a mosaic of low vegetation, including a mat-forming sedge (*Carex ramenski*i) and other herbs that produce flowering stalks that extend 1 to 2 feet upwards (*Triglochin maritimum, Plantago maritime*, *Potentilla egedii*). The highest areas, flooded only rarely, would be taken over by grasses (*Festuca rubra, Poa eminens, Deschampsia* species) and other herbs (*Ligusticum scoticum, Lathyrus palustris*) (HDR Alaska, Inc., August 1996).

An incidental benefit associated with the intertidal alternative would be increased flood control. Under normal flow conditions, all the water would flow out of the newly constructed intertidal channel. Since the existing weir would remain in place, it could be used during flooding episodes to drain excess water from the lagoon. There is no advantage to removing the existing weir from a biological or engineering perspective. The creation of the intertidal channel effectively removes a dam and likely reduces the flood hazard.

Railroad Bridge. To achieve an open channel, a railroad bridge would have to replace a portion of the existing track. Based upon guidance in Engineering Pamphlet 1165-2-1 (section 10-4.a(1) dated 30 July 1999), construction of the railroad bridge would be considered part of the Federal project and would be cost shared accordingly. A shoofly, temporary section of relocated track, would be constructed to allow rail traffic to continue during construction of the bridge. The embankment would be expanded to allow for the temporary section of track.

The bridge design is a ballasted three-span structure, with steel piles, pre-cast concrete abutments and pier caps, pre-cast girders, and a cast-in-place deck. After bridge construction was completed, the tracks from the shoofly would be removed. The ARRC is evaluating construction of a second track in the area of the Chester Creek project. If the ARRC decides to build a second track and fulfills their legal requirements, the fill for the shoofly would be left in place and used for construction of the second track. Otherwise, the fill would be removed.

Preliminary designs for the bridge are in appendix D. Costs for the trestle and associated work are estimated at $3.9 million. A detailed cost estimate is included in appendix C.

Figure 7. Touched up photo showing proposed trestle for Alternative 1

Open Intertidal Channel with Culvert (Alternative 2). This alternative incorporates the elements from alternative 1 but addresses the stream railroad crossing by containing the stream in an 18 to 19.5-foot diameter culvert with a length of 120 feet under the railroad track. The larger culvert is desired to accommodate the tidal fluctuations to reduce the periods where the culvert would flow full, resulting in a potential hindrance to fish for passage upstream. The factor that will govern the size of the culvert is the largest diameter that can be installed based on the allowable overburden pressure for the culvert. Further design would be required to ensure that the larger culvert is constructible and would work to structurally support the railroad line. Since this alternative includes the same intertidal channel design discussed in alternative 1, the environmental consequences are the same as those discussed above for the open intertidal channel with trestle. The environmental consequences of the culvert are considered below.

3.7.3 Culvert Diameters Considered

Various culvert diameters were considered and evaluated for Chester Creek passage under the railroad embankment. Culverts of 16-foot diameter or greater would meet the criteria for flow and submergence time during mean higher high water (MHHW). It is the minimum size that would meet requirements by ADF&G to keep the velocity flow in the culvert under 2.5 feet per second (fps). Based on flow calculations, it was found that the larger the diameter of the culvert, the closer the flow rates are to open channel flows. The factor that will govern the size of the culvert is the largest diameter that can be installed based on the allowable overburden pressure for the culvert.

A culvert of 19.5-foot diameter would be best suited for the goal of lowest flow velocity in the culvert. Normal summer flow in the culvert ranged from 1.0 fps at high tide to 0.7 fps at low tide. The 19.5-foot culvert design option has flows that are the closest to the railroad trestle/open channel design. The maximum depth of cover allowable for the 19.5-foot diameter culvert is 20 feet. If the bottom burial depth of the culvert is at –5 feet mean sea level (MSL), the crown would be at 14.5 feet MSL, and the depth of cover would be 19.5 feet, almost exceeding the maximum allowable depth of cover for the culvert. Table 4 shows the allowable and actual depths of cover for the various culvert diameters considered; table 5 gives the cost of the culvert for the diameters considered. Based on cost of the culvert and allowable verses actual depth of cover, the 18-foot diameter culvert appears to be best suited for the culvert design. Regarding flow rates within the culvert for the normal and annual flood, the 18-foot diameter culvert is suitable to handle flow rates at all tidal levels. All culvert sizes have flow rates that exceed the maximum design flow of 2.5 fps regarding the 500-year flood event.

Table 4. Culvert Size and Allowable Depth of Cover

Culvert Diameter	Bottom Burial Elevation–MSL	Crown Elevation MSL	Allowable Depth of Cover–ft	Actual Depth of Cover
16-foot	-5	11	27	23
18-foot	-5	13	27	21
19.5-foot	-5	14.5	20	19.5

Table 5. Cost Comparison for Culvert Sizes

Culvert cost comparison for multi-plate 0.25" thick, E80 Loading	Quantity		Cost ($)		Total
16-foot diameter	120	LF	770.00	$/LF	$ 92,400.00
Multi-plate Assembly	120	LF	200.00	$/LF	$ 24,000.00
Total					**$116,400.00**
18-foot diameter	120	LF	870.00	$/LF	$ 104,400.00
Multi-plate Assembly	120	LF	200.00	$/LF	$ 24,000.00
Total					**$128,400.00**
19.5-foot diameter	120	LF	1,500.00	$/LF	$180,000.00
Multi-plate Assembly	120	LF	200.00	$/LF	$ 24,000.00
Total					**$204,000.00**

3.7.4 Culvert Channel Design

The channel in the culvert would be designed as a riffle channel section. The streambed would consist of stream substrate that is intended to replicate naturally occurring streambed material. Stream substrate would be comprised of substrate and fines. Size data is in table 6. The slope of the channel would be 0.0195.

Table 6. Streambed Substrate Gradation

Substrate (provides channel stability)			Fines (limits surface flows)		
Percent gradation smaller than	Stone size range (in.)		Percent gradation smaller than	Stone size range (in.)	
	Min	Max		Min	Max
100	27	31	100	6.00	7.00
85	22	25	85	5.00	6.00
50	18	21	50	4.00	5.00
15	7	11	15	0.25	2.00

Three alternatives were considered for fish passage design in the culvert; these options included (1) no-slope, (2) hydraulic design, and (3) streambed simulation. The no-slope option consists of a culvert placed on zero percent grade, with fill placed in the bottom of the culvert by natural stream processes or during construction to simulate a channel in the culvert. The hydraulic design option is designed with a target fish in mind; the culvert would be dimensioned to meet the flow velocity required for passage of the design fish during low and high discharge periods. The streambed simulation option is designed to mimic the open channel flows outside the culvert; ideally the culvert substrate width would be 1.2 times wider than the channel width outside the culvert, and flow in the culvert would be synonymous with flow outside the culvert. The hydraulic design option is the recommended culvert design for Chester Creek. Further discussion of the three design options can be found in appendix D of this report.

3.7.5 Utility Relocation

Both alternatives would incorporate the intertidal channel and relocate the utilities on the inlet side of the railroad tracks. The following utilities oould be affected by the channel's construction.

3.7.5.1 Tesoro Pipeline

Tesoro has operated a 10-inch steel petroleum pipeline adjacent to the west side of the railroad embankment since 1976. This pipeline is buried about 7 feet deep and immediately above the creek culverts. Approximately 200 feet of pipeline would have to be relocated to construct the creek channel. Options of hanging the pipeline from the new railroad trestle and burying the pipeline below the reconstructed creek were discussed with Tesoro. While hanging the pipeline from the trestle is feasible, the pipeline would have to be protected from vandalism and ice damage. Burying the pipeline avoids these concerns and maintains the pipeline alignment. Directional drilling was not considered because the AWWU force mains would be reconstructed with open trench construction, and the Tesoro pipeline relocation could be coordinated with the force main relocation.

One alternative for burying the pipeline below the reconstructed channel would be to excavate long segments on either side of the new channel and sag the pipeline to the new position by gradually lowering the pipeline in these trenches to the new elevation. This could require several thousand feet of trench excavation. A second option would be to drain the pipeline and cut in a new segment of pipeline at the creek crossing. This alternative would require draining the pipeline and would have to carefully consider the potential for a fuel spill, but it would impact the least area during construction activities. Burying the pipeline below the reconstructed channel and cutting in a new section of pipeline is the recommended option because it is the least damaging to the area.

3.7.5.2 AWWU Force Mains

The AWWU has operated a 30-inch sewer force main since 1972 and a 42-inch sewer force main since 1984 on the west side of the railroad embankment. The 30-inch main is immediately to the west of the Tesoro pipeline and the 42-inch main is immediately west of the 30-inch main. The force mains are buried about 5 feet deep and above the creek culverts. The two force mains would have to be relocated to allow for creek channel construction. Options of hanging the force mains from a new railroad trestle and relocating the force mains below the new channel were evaluated by AWWU for this project. The AWWU concluded the most cost-effective option would be to relocate the mains below the reconstructed channel. This would be done by trenching through the existing fill, constructing new piping below the proposed channel bottom, connecting the new pipe to the existing force main, and abandoning the old, disconnected piping. Directional drilling was not considered because of its high cost for this size of pipe.

3.7.5.3 AFSC Petroleum Pipeline

The AFSC has operated a 12-inch steel petroleum pipeline immediately west of the AWWU 42-inch sewer force main since 1998. The pipeline is buried above the creek culverts. As part of the easement and permitting process, AFSC entered into a contract with the MOA and the Department of Natural Resources that stipulates AFSC will relocate their pipeline at their cost when the creek channel is restored. For the purposes of this evaluation, it was assumed the relocation would use the same method as the relocation of the Tesoro pipeline.

Figure 8. Touched up photo showing proposed culvert for alternative 2.

Table 7. Alternative cost table

Item	Alternative 1 (Trestle)	Alternative 2 (Culvert)
	($000)	($000)
Channel construction	2,378	2,082
Bridge & Tracks	3,585	0
Culvert construction	0	1,316
Total contract cost	**5,963**	**3,398**
Utilities	1,800	1,800
Lands & Damages	108	108
Engineering & Design	400	400
Contract Administration	513	308
Study Costs	575	575
Monitoring	100	100
Interest During Construction	398	243
Total Project Cost	**9,857**	**6,932**
Maintenance	Alternative 1 (Trestle)	Alternative 2 (Culvert)
Inspection Costs (yearly)	4	1
Replacement Costs	3	3
Replacement Interval	Yearly	10 Years
Ecological Benefits		
Intertidal Channel	1,168 feet	1,062 feet
Spawning Habitat Accessed	4.7 miles	4.7 miles

3.8 Environmental Consequences

Environmental consequences were discussed in a previous EA prepared in 2001. Whereas the 2001 EA considered the entire creek, the current project is limited to fish passage at the mouth. The following is a discussion of consequences not covered in the previous EA.

3.8.1 Impacts of the No-Action Alternative

Fish passage would continue to be severely restricted. Out-migrating juveniles, if any managed to survive, would continue to face significant osmoregulatory challenges upon leaving Chester Creek for saltwater.

3.8.2 Impacts of the Proposed Actions

3.8.2.1 Physical Environment

Climate and Air Quality. Potential impacts to air quality were studied and the results were discussed in a report prepared by HDR Alaska in July 2002 "Conformity analysis for the Section 206 Aquatic Ecosystem Restoration Project Chester Creek." The report is included as Appendix H of this report.

Water Quality. The newly created intertidal channel and the small pond connecting the channel to Westchester Lagoon would become more tidally influenced and would flood periodically. The salinity in Westchester Lagoon would likely remain unchanged.

Noise. Heavy equipment would operate in the area during construction of the intertidal channel and culvert installation. Noise from these activities would primarily be produced during daylight hours and would probably be confined to a period of a few weeks. Passers-by would be temporarily exposed to noise levels typical of other construction projects in town. Some homeowners are adjacent to the project site and construction noise would be audible. Noise would be primarily limited to excavators, loaders, and dump trucks. Blasting or other uses of explosives is not anticipated. Homeowners in this area are routinely exposed to loud noises from the adjacent railroad line. Increased noise from this project would be limited to the construction period.

Noise would also be produced by efforts to relocate utilities on the mudflats. The noise produced by utility relocation would likely be less than those produced by work at Westchester Lagoon since the railroad berm would likely block much of the noise.

3.8.2.2 Biological Environment

Benefits of the proposed activity are discussed in section 3.9 below.

Fish and Wildlife. Waterfowl sometimes use small ponds and grassy areas in the upper-intertidal area of Cook Inlet near Westchester lagoon. These birds may be temporarily displaced during construction. The intertidal channel would lead to periodic flooding during high tides and the wetlands would no longer be suitable for waterfowl nesting.

Utility relocations and culvert installation would be in the fall to spring window. Channel excavation and disposal for creation of the bird island would occur during the summer when the lagoon can be de-watered. De-watering the lagoon would comply with existing MOA de-watering permit stipulations. De-watering is necessary to accommodate replacement of the radio tower gridlines and for ease in placing excavated materials into the lagoon for creation of the bird island. The material would be placed by forming a peninsula into the lagoon then breaching it to form the island. Chester Creek would continue to flow during construction

Beluga whales and harbor seals may be found in the area offshore of Westchester Lagoon. Since utility relocation can only take place when the tide is out there should be no in-water activity that may disturb these marine mammals. In the future, an increased run of anadramous fish would likely benefit marine mammals.

3.8.2.3 Recreation and Transportation

The existing pedestrian trail (Tony Knowles Coastal Trail) is heavily used year round. A temporary alternate route would be constructed. Construction duration is expected to be several weeks. Most likely traffic would be diverted to a temporary trail on the west or inlet side of the railroad tracks. Another option is to require traffic to go east towards Minnesota, up the hill to West High School, and then over to Woodworth Circle. This option is not as desirable since it puts traffic on residential streets and increases the length of the trail significantly. Options are still being investigated and being coordinated with the community and the Municipality's Department of Parks & Recreation. The coastal trail would be modified by providing a viewing platform to keep the trail clear for bikers, etc.

The railroad would be shutdown approximately 48 hours while the culvert is put in place.

3.9 Ecological Benefits

A summary of the benefits is shown in table 8 and compares the without-project conditions and the with-project conditions. To help quantify the benefits to aid in alternative selection, a habitat evaluation for juvenile coho salmon was completed using the Habitat Evaluation Procedures (HEP) for several potential project locations.

The fundamental unit of measure in HEP is the Habitat Unit, computed as follows:

HU = AREA x HSI

where HU is the number of habitat units (units of area); AREA is the aerial extent of the habitat being described (units of area); and HSI is the index of suitability of the habitat (unit less). Conceptually, an HU integrates the quantity and quality of habitat into a single measure, and one HU is equivalent to one unit of optimal habitat. The suitability of a habitat for a given species is described by an HSI constrained between 0 (unsuitable habitat) and 1.0 (optimum habitat). Habitat suitability index models have been developed and published by the U.S. Fish and Wildlife Service (1981), and they provide guidelines for use in developing HSI models for specific projects.

The Alaska Department of Fish and Game, the FWS, and the Alaska District, Corps of Engineers, characterized habitat on Chester Creek. Habitat is expressed in HU for adult and juvenile coho salmon. A habitat suitability index model for coho salmon has not been established for Chester Creek; Alaska District and FWS biologists familiar with Chester Creek and fish habitat improvements derived habitat suitability indices.

Table 8. Existing Habitat vs. With-Project Habitat

	EXISTING	POST-RESTORATION (with some historical estimates)
WETLANDS	Freshwater emergent/scrub-shrub wetlands dominated by Calamagrostis canadensis and remnant salt tolerant vegetation (loss of habitat diversity from original estuarine conditions). Designated high value by Anchorage Wetlands Management Plan (Preservation Wetland) Identifies site as approx. 10 acres/Public Ownership; Documented high habitat, recreation, and water quality values.	Intertidal (esturarine) wetlands dominated by mud flats, salt and tide tolerant vegetation, including Lyngbye sedge, among other sedges (restore habitat diversity). Calamagrostis canadensis still will be present in areas above high tide limit. Estimates of intertidal area restored is about 4.5 acres. Remaining acreage will retain its freshwater wetland status, with a small acreage of upland (berms) constructed below pond. Rough estimates of original estuarine wetlands from 1950 aerial photography is approximately 60 acres.
FISH	Current conditions consist of almost completely blocked fish passage. No osmoregulatory area for anadromous salmonids. Estimated coho return between zero and 24 spawners in the upstream reaches of Chester Creek between 1996 and 1999. No feeding/resting areas for migrating salmonids. No woody debris present. Pre-1942 estimate of coho spawners is 2000 fish.	Approximately 10 stream miles long from its headwaters in the Chugach Mountains, restoration here will open up access to spawning habitat for adult anadromous salmonids and smolts as they leave the watershed. Potential for restoration of coho runs (est. 500–1000 spawners (Peltz, pers. comm.) in concert with other instream and riparian habitat restoration in upstream reaches. Potential for restoration of other species of salmon known to historically occupy watershed (chum and pink). The restoration of intertidal (estuarine) wetlands will include holding areas for adult and juvenile anadromous fish to osmoregulate (933 ft instream). Woody debris placement in existing pond and freshwater channel (235 ft)will provide cover habitat for both returning adult and resident juvenile fish and is associated with an increase in macroinvertebrate production.
MIGRATORY	Current freshwater wetlands used by passerines	Estuarine wetlands will be used by migratory birds,

BIRDS	and waterfowl.	including shorebirds, waterfowl, and raptors. Estuary will provide resting and nesting (potentially depending on disturbance) areas for birds. Potential increase in eagle or other raptor use, gull and tern use, and shorebird use.
WATER QUALITY	Water quality limited in freshwater pond (serving as contaminant sink) due to input of runoff from surrounding urban community and lack of flushing (no inlet/outlet channel), resulting in increased concentration of chemical pollutants. Pond is shallow and maintains increased water temperature. Decrease in macroinvertebrate prey in freshwater areas. Increase in potential for bioaccumulation poisoning.	Restored site will improve water quality within the pond by enabling the pond to flush into Cook Inlet (Chester Creek will flow into and out of pond), resulting in decreased concentration of chemical pollutants. Increase in macroinvertebrate density expected in freshwater areas. Construction of deepened channel will result in coolwater habitat. Reduction in potential for bioaccumulation poisoning.
INSTREAM	Two 300-foot long culverts (effective loss of fish habitat) and inoperable fish ladder. Sharp freshwater/saltwater interface. Aerial photos from 1950 of the estuary show approximately 3300 linear feet of intertidal channel above railroad berm.	Installation of large diameter (18+ ft) culvert 123 ft long (or trestle) will reduce water velocities and lessen homogenous channel unit. Stream simulation is the option of choice for culvert dimension selection. Creation of 1168 ft long creek channel will include: 235 ft freshwater and 933 ft intertidal (fresh/saline water mixing). A 385 ft meandering channel will be dug through existing pond as coolwater habitat for fish. No change is expected to overall pond footprint. Step/pool sequence within intertidal area will provide habitat complexity for salmonids, including pools for resting. Pool habitat here is maximized for freshwater/saltwater mixing. Will effectively eliminate sharp freshwater/saltwater interface (i.e., restore estuary-type conditions).

3.9.1 Fish Passage

Adult coho salmon escapement to Chester Creek is limited by the passage at the railroad crossing. Since fish passage to Chester Creek is so poor, the value of the spawning habitat is very low, with an HSI of 0.05. With the proposed fish passage facility, the improved access to the spawning habitat would raise the HSI to about 0.5. There are approximately 7,700 square meters (4.7 stream miles) of adequate spawning habitat that would be opened with the fish passage facility at the railroad crossing. The present value for the existing conditions for coho salmon spawning is 385 HU. With the proposed fish passage facility, there would be 3,850 HU, an increase by a factor of ten.

3.9.2 Inter-Tidal Area

The importance of incorporating an intertidal area in a restoration project involving salmon cannot be overstated. A complex series of physiological changes take place when juvenile salmon (smolt) leave their natal streams for their life in the ocean and when adult salmon return from the ocean to freshwater to spawn. These physiological changes associated with adaptation of the smolt to seawater include structural and morphological changes of the gills, esophagus, intestine and kidney to allow the smolt to deal with the markedly different ionic gradient encountered in seawater. Changes also take place on a chemical level involving metabolism, respiration, and cardiovascular systems. The smolt must also have an area to adjust to the abrupt change in temperature that typically exists between a shallow water lagoon (Westchester Lagoon) and the ocean.

These physiological changes take place over a period of several days to weeks as part of a process known as smoltification. An intertidal area is essential for the final phases of smoltification so that the smolt can gradually adjust to increasingly saline water. Without creating an intertidal channel in Chester Creek, smolts would move directly from freshwater to saltwater with absolutely no acclimatization period. Additionally, mortality would likely increase dramatically and essentially render the restoration project useless since salmon would be unable to complete their life cycle and return to spawn in later years. Transition from freshwater to saltwater is naturally a high mortality event and the lack of an intertidal acclimatization area would only serve to exacerbate the high mortality rate. A similar situation exists regarding adult salmon that are returning to spawn, although far less study has been devoted to them. Unlike the smolts leaving Chester Creek via Westchester Lagoon that are "dumped" directly into saltwater, the returning adults can congregate where the freshwater enters the ocean through existing culverts and acclimate to some degree. However, the proposed intertidal channel is vastly superior for returning adults than the existing, and largely nonfunctional, fish ladder.

The proposed intertidal channel that would be created by this project would be approximately one-third the length of the natural intertidal area that existed in the 1970s. This could have three potential effects. One, it compresses the gradient of salinity change from fresh to saltwater. However, many natural systems have similarly small areas of fresh and saltwater mixing so the proposed channel should be of sufficient length, especially because it incorporates a brackish water pond as additional habitat. Two, there would be less intertidal habitat area than the natural condition in the 1970s. This might be a concern if there where too many fish for the habitat area, but since the number of returning adults has been very low for the past several decades, it is unlikely that carrying capacity of the habitat would be exceeded. Three, the decreased length and therefore increased steepness of the channel may not permit smolts to move back upstream to the brackish water pond once they have entered the intertidal channel if the tide is out and the flow in the channel is too great. This effect may be counteracted by the presence of the pond where fish can acclimate to different salinity levels within the pond itself before making their final push towards out-migration.

Assuming that the original intertidal habitat prior to development was optimal (1.0 on a scale of 0 to 1.0), it would be possible that the proposed project could raise the habitat value from 0 (since no intertidal channel currently exists) to .75. The proposed project would create approximately 18,210 square meters (4.5 acres) of intertidal wetlands, a 13,658 HU increase. with the trestle alternative there would be an additional 1214 square meters (.3 acres) of intertidal wetlands for an additional 910 HU increase

3.9.3 Cost-Effectiveness and Incremental-Cost Analysis

It must be shown through cost-effective analysis that an alternative restoration plan's output cannot be produced more cost effectively by another alternative. "Cost effective" means that, for a given level of non-monetary output, no other plan costs less, and no other plan yields more output for less money. Subsequently, through incremental-cost analysis, a variety of implementable alternatives and various-sized alternatives are evaluated to arrive at a "best" level of output within the limits of both the sponsor's and the Corps' capabilities.

Usually, the incremental analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (for example, significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help select and recommend a particular plan.

Corps planners can use IWR-PLAN to compare the incremental environmental outputs or benefits gained with successively more expensive ecosystem restoration plans. IWR-PLAN also helps formulate compound alternatives from simple user-provided measures. In a typical ecosystem restoration study, there are many possible measures that could be implemented independently or in various combinations. Ideally, a planner would like to see the costs and environmental benefits of each combination. IWR-PLAN 3.0 makes it easy to form these combinations and then evaluate their costs and benefits.

IWR-Plan was not used for analysis in this study. Often such analyses are time-consuming and complicated. Initially the study looked at 50 potential projects along the entire stream corridor and could have benefited from utilizing the model but through stakeholder participation all other plans were eliminated recognizing the importance of restoring access to the stream system for salmon and thus focused primarily at the mouth of the lagoon to find measures to restore the fish passage. The several of the fish passage measures analyzed were eliminated not primarily because of cost but because of effectiveness and acceptability. These measures and their reasons for elimination were stated earlier in section 3.6. This screening of measures greatly reduced the complexity of the evaluation process and therefore did not require the model to determine the incremental analysis of the options that remained.

What did remain were basically two alternatives utilizing three measures: a trestle, a culvert, and an open channel. The majority of the variations for each of these measures were optimized through the design criteria and existing conditions such as load requirements for the rail crossing, velocities acceptable for fish passage, wave conditions, tide range, and flood levels for the site. Costs were then generated for the implementation and maintenance for the three measures and values were attributed to the ecological benefits.

Selection of the culvert size is discussed in section 3.7.3 of this report and shows a range of culverts analyzed for this project ranging from 16 to 19.5 feet in diameter. Table 5 shows costs associated with the three culvert sizes considered. Ascribing ecological benefits for the various culvert sized considered would be qualitative with a reasonable assumption that there is an increase in quality with increase in the size of the culvert. Quantifying the differences for the various sizes would be very difficult to give an accurate incremental cost associated with the benefit. The 18 foot diameter culvert was selected based on the incremental cost in size, velocities for fish passage at all tide levels, and allowable overburden depths.

The measures and the associated benefits are shown in table 9 below. The values for the habitat outputs used, HU are explained in section 3.9.2 of this report. The costs were derived from the MCACES cost estimate developed for the project. The table shows the costs and the benefits of the measures individually and also provides the combinations with additive costs. It should be pointed out that none of the measures would achieve the benefits alone. What the analysis shows is that both the culvert and the trestle plans with the intertidal channel are cost effective. This is shown on figure 9. It also shows there is an increase in the quantity of the habitat that the trestle offers over the plan using a culvert. The additional 910 HU (120 feet of open intertidal channel) produced by the trestle, alternative 1, costs $3,000 per HU ($23,100 per foot of intertidal channel). The culvert plus the intertidal channel, alternative 2, can produce the first 17,508 HU at $300 per HU ($173 per foot of intertidal channel and stream).

Table 9. Cost-Effectiveness and Incremental-Cost Analysis

Cost-Effectiveness Analysis

	Cost* ($000)	Benefits (HU)	Incremental cost ($000)	Incremental outputs (Benefits)	Incremental Cost/output ($000)/HU
no action plan	0	385			
culvert (C)	1421	3850			
trestle (T)	4191	4760			
intertidal channel (IC)	4207	13658			
IC+C	5628	17508	1421	3850	0.369
IC+T	8398	18418	2770	910	3.044

Incremental-Cost Analysis

Alternative	Description	Cost* ($000)	O&M	Ecological Benefits	Cost per HU $/unit ($000/HU)	Cost per add. 120 ft ($000/HU)
1	open intertidal channel w/ trestle	8,398	$1k/yr inspection $3k/yr routine maint.	1,168 ft of intertidal channel, 4.7 stream miles spawning habitat	0.5	3.0
2	open intertidal channel w/ 18 ft culvert	5,628	$1k/yr inspection	1,062 ft of intertidal channel, 4.7 stream miles spawning habitat	0.3	

*Study and PED costs not included
Restored area = 4.5 acres intertidal wetlands, 4.7 river miles(11.4 acres),w/trestle(11.7 acres)
4.5 acres = 13,658 HU, 4.7 river miles = 3,850 HU, trestle adds 910 HU

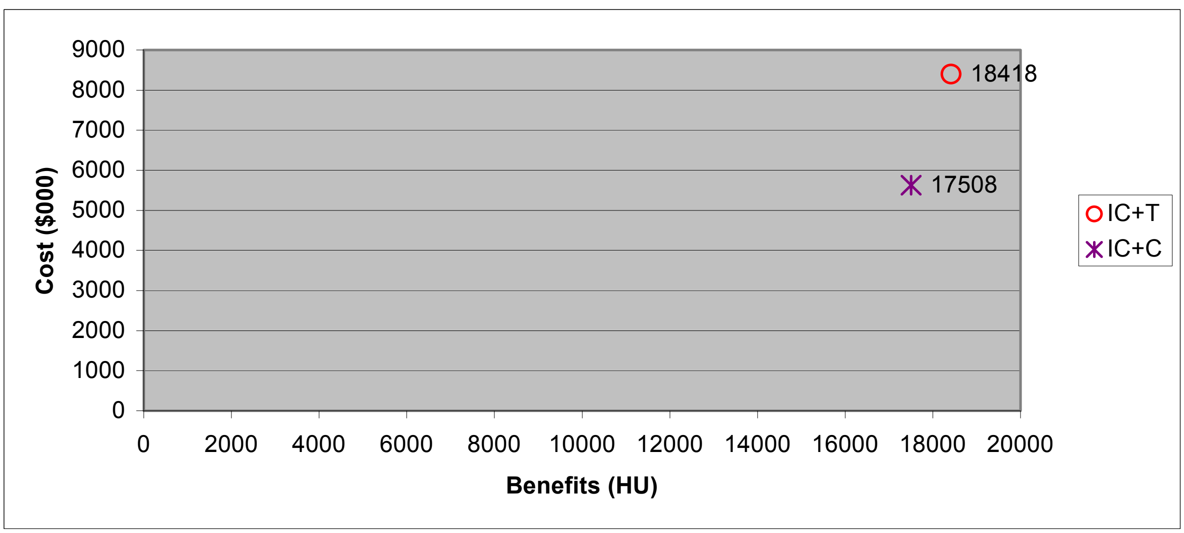

Figure 9. Cost-effective analysis

4.0 DESCRIPTION OF RECOMMENDED PLAN

4.1 Plan Components

Preferred Alternative. After consideration of the environmental factors, design factors, constructability, cost, and restoration goals, it was determined that the alternative to construct an open channel from the lagoon under a bridge (trestle) to the inlet (figure 7) would provide the most environmental benefits. This alternative is also the most costly one considered. The incremental cost is $2,770,000 total project cost and $3,000 in yearly maintenance. The benefit associated with this cost is hard to quantify when considering that the open channel under the trestle would provide the most natural function and appearance to the mouth of Chester Creek. As shown in the incremental-cost analysis, the incremental benefit would be to add 120 feet (length of culvert) to the length of the intertidal channel being restored. Based on the high cost for the incremental benefit, it was determined that the Open Intertidal Channel with Culvert (alternative 2) was the NER recommended plan and is described in this section**.**

4.2 Open Intertidal Channel with Culvert (Alternative 2)

An open stream channel would be constructed from the lagoon and go through an 18 to 19.5-foot culvert under the railroad track and empty into Cook Inlet. Details of the preliminary design can be found in appendix D.

Utility Relocation. Five buried utilities are on the west side of the railroad tracks: a gravity sewer main, two sewer force mains, and two petroleum pipelines. There is also a fiber optic cable. To construct the channel, all except the gravity main sewer and the fiber optic line would need to be relocated to a depth below the thalweg of the channel. This work is scheduled to be completed before the recommended project.

Maintenance vehicles access the utility lines from the north, driving along the toe of the railroad embankment. The creek is in culverts at this location, allowing vehicles to cross. Once the existing culverts are removed and the new culvert is in place, access to the south side of the creek would be prevented. Access from the south would need to be obtained to include obtaining rights-of-entry from a private property owner and the ARRC.

Open Channel. The new channel would connect Chester Creek between Westchester Lagoon and Cook Inlet. A plan view of the proposed channel is shown on figure 10. A more detailed description of the channel can be found in Appendix D of this report. Drawings of the proposed channel and other details are in Section 7 of this report. The channel would drop 21.3 feet, traversing an intertidal zone over the majority of its length. The stream channel is being designed to pass through a pond on the south side of the project footprint to optimize habitat values. The length of the channel, including the reach passing through the pond, would be about 1,550 feet. The channel would also include a spillway or weir where the channel leaves the lagoon. The weir would maintain the lagoon's water at the existing constant level and allow fish to pass. Also, 190 feet of the pedestrian trail would need to be reconstructed with pavement and a pedestrian bridge would be constructed to cross the new open channel.

A radio tower is at the east end of the project site. The channel would be designed so as not to affect the structural integrity of the tower and the tower ground system field strength. The ground grid extends around the tower and cannot be avoided. Portions of the grid would be replaced to ensure that the tower's function was not diminished by the proposed project. This work would need to be coordinated with the tower's owner/operator to ensure construction could be accomplished without interruption to the facility.

A Design Study Report for the channel work is included in appendix D along with drawings and a hydraulic analysis. It is recommended that during plan and specifications development that a coastal analysis be conducted to ensure adequacy of the proposed design. Costs for the channel work to include the pedestrian bridge and weir, are estimated at $2.1 million. A detailed cost estimate is in appendix C.

Fish Passage Culvert. The hydraulic design option is the recommended culvert design for Chester Creek. Based on the swimming abilities of the target species and class of fish, the flow velocity in the culvert must not exceed 2.5 fps; however, it is desired that the flow velocity be as close to 1 fps as possible. The design fish for the fish passage culvert is primarily coho salmon. The streambed within the culvert would be made to simulate a natural streambed by placing riprap and stream substrate material mixed with fines to construct a thalweg that simulates the natural meander of a streambed. The streambed material in the bottom of the culvert would be designed to mimic the channel constructed between the outlet at Westchester Lagoon and the upstream opening of the culvert. If the fill was approximately 4.5 feet thick in the bottom of the culvert, about 200 cubic yards (yd^3) of streambed material would be required to form the stream channel for the 18-foot culvert. Two feet of bedding would be required below the culvert, resulting in a total excavation elevation of –7 feet MSL. To place the culvert it is estimated that a total of 4,015 yd^3 of soil would be excavated for the project. This includes up to 100 feet in length, 25 feet of railroad embankment, and 16 feet of native soils. The railroad embankment material would be stored onsite and reused. Where in-situ materials had previously been, an additional 670 yd^3 of bedding material would be installed beneath and around the culvert bottom. Culvert length would be approximately 106 feet including a 5-foot buffer on either end from the railroad embankment. The average slope for the streambed within the culvert would be 0.0195. Structurally, the culvert and streambed would be designed to withstand a 500-year flood event. Figure 11 shows a concept image of the culvert. Figures 12 and 13 show cross-section drawings of the culvert.

Material Disposal. Excavated material from the channel construction would be used to create a bird habitat island(s) in Westchester Lagoon. Placement and size of the island(s)would be determined during the plans and specifications phase of the project. Material excavated from the Railway embankment that is not used for the culvert placement will be hauled to a site south of the project area on upland railroad property to be used as fill.

Existing Outlet Structure. The existing outlet structure would continue to provide flood conveyance. The structure would also be necessary to drain the lagoon and because an existing 48-inch storm drain outfalls into the north side of the outlet structure. Draining may be needed for periodic maintenance of buried utilities under the lagoon. A portion of the outlet pipes would need to be retained. The existing pipes would be slip lined, replacing the existing lines and incorporating them into the new channel design and culvert. The existing fish bypass connecting the lagoon to the inlet structure would be filled with control density fill and the inlet end would be buried and cut off.

Work Staging Area and Pedestrian Traffic Diversion. Due to existing development in the area, locations for equipment staging are limited. Staging of equipment would occur primarily in the parking lot at the intersection of U Street and West 15th Avenue. The area is rather small and would be expanded. The area would be re-paved upon completion of the project. Construction vehicle traffic and noise would be minimized to the extent practicable since the area is in a residential neighborhood.

The existing pedestrian trail (Tony Knowles Coastal Trail) is heavily used year round. A temporary alternate route would be constructed. Most likely, traffic would be diverted to a temporary trail on the west or inlet side of the railroad tracks. Another option would be to require traffic to go east towards Minnesota, up the hill to West High School, and then over to Woodworth Circle. This option is not as desirable since it puts traffic on residential streets and increases the length of the trail significantly. Options are still being investigated and being coordinated with the community and the Municipality's Department of Parks & Recreation.

Construction Issues. The MOA and/or the Alaska Department of Transportation and Public Facilities (ADOT&PF) owns the land. The MOA land east of the ADOT&PF right-of-way is zoned as Public Lands Institute (PLI) and is part of the Chester Creek greenbelt. The greenbelt is dedicated parkland and managed by the MOA Department of Parks & Recreation. The Chester Creek bike trail crosses the project site. Pedestrians and bicyclists would have to be routed around the project site during construction. Equipment would be staged in the immediate area. Prior to construction the COE would need to coordinate with the State of Alaska Dam Safety Engineer and apply for a permit to modify the dam that creates Westchester Lagoon. A dam analysis was prepared for the MOA and a copy is included as appendix I of this report.

Figure 10. Touched up photo showing proposed project.

Figure 11. Existing conditions (above) compared to touched up photo (below) showing proposed culvert during low flow and low tide.

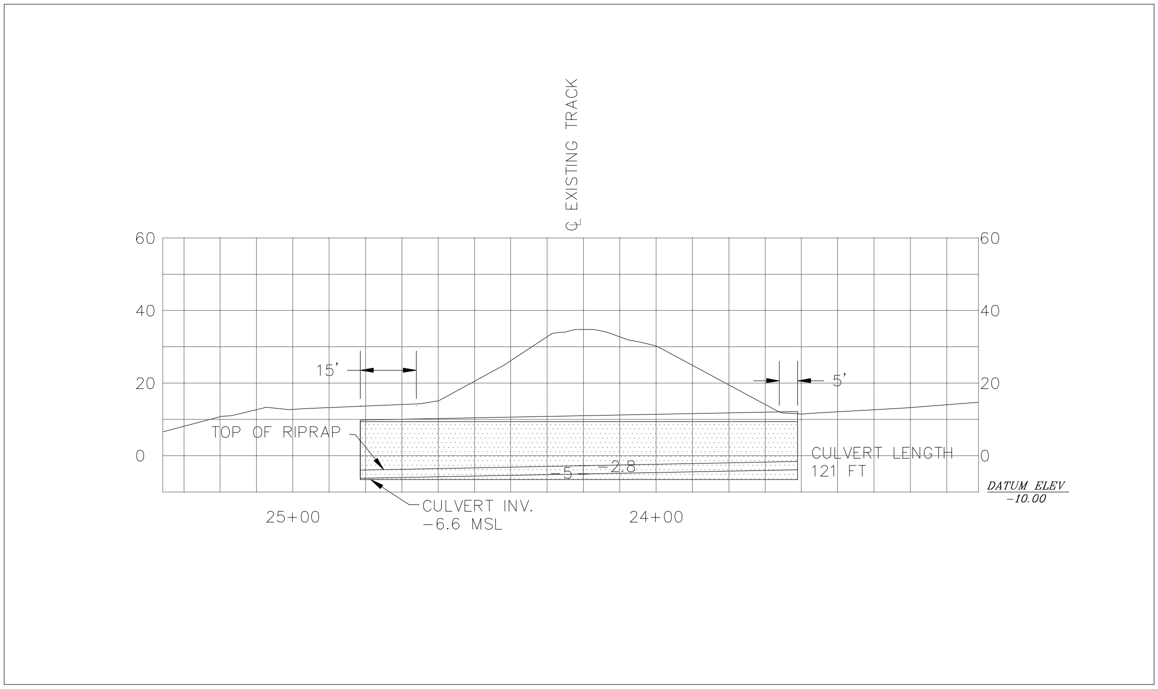

Figure 12. Cross section of culvert

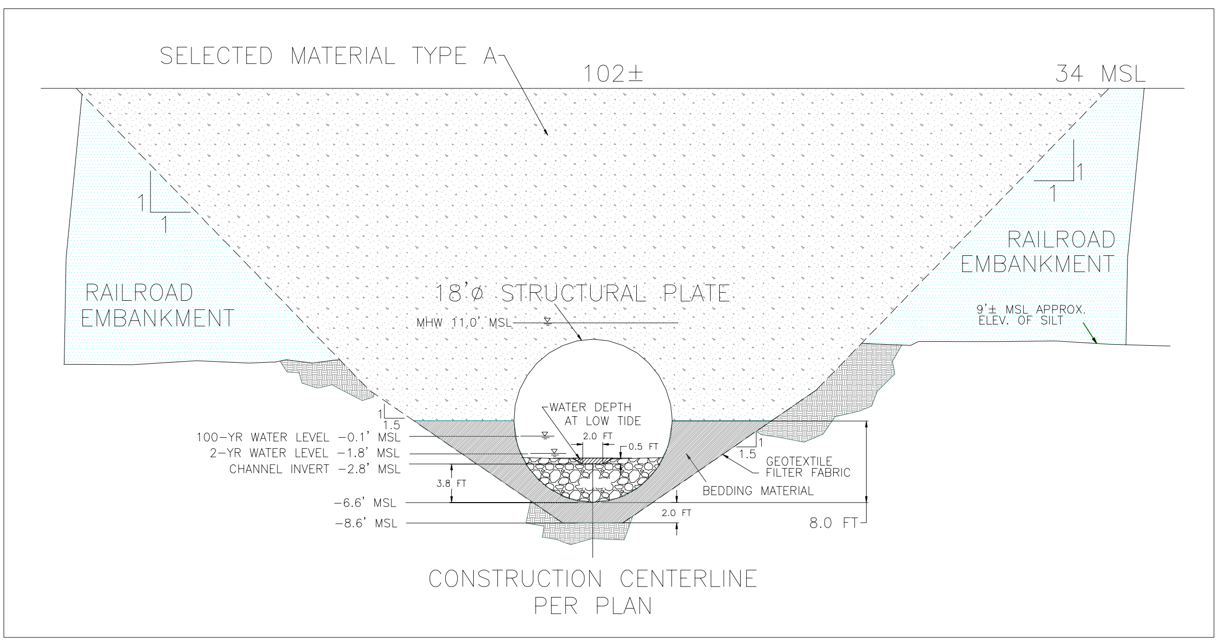

Figure 13. Cross section of culvert

Cost Estimate. Table 10 presents a cost estimate for the recommended project. Detailed cost estimates are shown in appendix C. Included in this estimate are construction and contingency costs, and estimates of design and project administration costs. Contingency is calculated as a percentage of the construction cost, and the percentage used is considered the industry standard for this level of cost estimate. Design and administration costs are calculated as a percentage.

The percentage used is derived from experience with similar projects in the Anchorage area. These estimates are planning level cost estimates only.

Table 10. Federal/Non-Federal Cost Apportionment for Recommended Plan

Items	Total Project Cost ($000)	Implementation Costs ($000)	
		Federal	Non-Federal
Feasibility Phase			
Study Costs	575	374	201
Plans & Specifications Phase			
Design & Prepare Plans & Specifications	400	260	140
Construction Phase			
Project Features:			
Channel Construction	2,082	1,353	729
Culvert Construction	1,316	855	461
Construction management (S&A)	308	200	108
LERR Administrative (Federal)	30	20	11
Adaptive Management/Monitoring	100	65	35
Subtotal	4,811	3,127	1,684
LERR Costs			
Utility Relocations			
Tesoro POL Pipeline	577		577
Sewer Mains	1,006		1,006
LERR Administrative (Local Sponsor)	30		30
Realestate Acquisition	106		106
Subtotal	1,719		1,719
Total Project Cost			
Federal/Non-Federal Cost Share	6,530	3,127	3,403
Non-Federal project Credits			
In-kind			0
LER (admin & acquisitions)		136	-136
Utility Relocations*		1583	-1,583
Total Credit		1,719	-1,719
Total Project Cost (Adjusted)	**6,530**	**4,846**	**1,684**

* Determination of compensibility may result in some of these costs not being creditable.

4.3 Monitoring and Adaptive Management

Assessment of the existing conditions at the site is essential prior to habitat construction. This assessment should include an inventory of existing vegetation, field data from bird surveys in the immediate area, and fish survey and water quality data from the pond.

Monitoring data should focus on obtaining information on dimension, pattern, and profile of the newly constructed channel. In addition, water quality monitoring would occur within the pond (oversight by Anchorage Waterways Council), fish surveys should be conducted within the pond and in the newly constructed channel, as well as in upstream reaches (e.g., to determine populations densities based on age class and to document numbers and species of adults during migration), macroinvertebrate monitoring within freshwater reaches on the newly constructed channel, and avian surveys within the project area during migration, breeding season, and winter. The monitoring plan for this project will be more fully developed as the project progresses.

Monitoring would occur up to 5 years beyond construction. Periodic inspections of the culvert and channel would also have to occur, especially after high water events. If fish have difficulty navigating the channel, or the channel becomes unstable, appropriate adaptive management measures would be taken to rectify the problem. It is estimated that annual costs are $20,000 for a total of $100,000.

4.4 Plan Benefits

The recommended plan maximizes ecological benefits and accomplishes the project purpose, while minimizing costs. A true incremental analysis is not practicable for this project since the project is not restoring a specific number of acres of habitat or a linear distance of stream beyond the new channel being proposed that provides access to the rest of the system. The recommended plan would (1) increase the number of adult salmon that are able to enter the stream; and (2) increase the survivability of juvenile out-migrating salmon. The proposed plan would increase the habitat units for the stream from 385 HU to 17,508 HU.

4.5 Plan Costs

For projects authorized by Section 206 of the Water Resources Development Act, the cost share is 65 percent Federal and 35 percent non-federal with a Federal limit of $5 million. Prior to execution of a project cooperation agreement (PCA), the non-federal sponsor's share of the cost, for the feasibility phase, and the plans and specifications phase, is initially Federally financed. The non-federal sponsor is responsible for these costs when the PCA is executed. These costs are considered to be part of the total project cost and will be recovered from the non-federal sponsor after PCA execution in proportion to the project cost-sharing procedures for the project purpose. The non-federal sponsor shall provide all lands, easements, rights-of-way, relocations (LERR) required for the restoration project and shall also be responsible for 100 percent of the OMRR&R.

The total estimated project cost is $6,530,000. The Corps' funding requirement is estimated at $4,846,000. The non-federal cost requirement is estimated at $1,684,000 after crediting of $136,000 for administrative and acquisition costs, and $1,583,000 for utility relocation. Table 10 shows the breakdown for the estimated total project costs.

4.6 Risks and Uncertainty

As in any planning process, some of the assumptions made in this report are subject to error. Elements of risk and uncertainty could affect the design, cost, and/or degree of success. Risks have been minimized to the extent practicable. Experts with experience have been consulted in the design of the creek channel, railroad bridge, and culvert. A hydraulic model has been run showing that the design of the channel would work with minimal risk for adverse impacts. To be sure the project is successful, the channel would be monitored to ensure that the project goals and objectives come to fruition.

4.7 Plan Accomplishments

The recommended plan would meet the planning objectives in the following ways:

- Improve fish passage for anadromous fish.
- Provide habitat for salmon to acclimate to changes in salinity.
- Would not increase flood risks.

4.8 Plan Implementation

4.8.1 Construction

Federal. The Corps of Engineers would be responsible for construction of the weir, the open channel, culvert, and pedestrian bridge over the new channel, and repairs to the pedestrian trail. The Corps of Engineers would also be responsible for the disposal of the excavated materials in the lagoon for construction of bird nesting islands.

Local. The sponsor would be responsible for the relocation and replacement of the utilities impacted by the project. These include the four pipelines for the open channel construction and the fiber optic cable.

4.8.2 Operation, Maintenance, Repair, Replacement, and Rehabilitation

Federal. The Corps of Engineers would conduct periodic inspections of the project for no more than 5 years after construction to monitor the improvements to fish passage and habitat, and to determine maintenance needs. The number of fish entering the system would also be documented.

Local. Under the Section 206 program, the local sponsor assumes all maintenance responsibility for the project. All costs associated with operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) for the project is 100 percent non-federal. The MOA would be responsible for all maintenance of the weir, open channel, and pedestrian trail bridge. The ARRC would assume maintenance of the culvert and tracks. Minimal maintenance is anticipated. Wood on the trail bridge and viewing platform would need to be replaced and maintained periodically. Maintenance would include the stabilization of disturbed soils to prevent erosion.

4.8.3 Real Property Interest

The sponsor would provide all lands necessary for the project. The MOA, the local sponsor, and the Alaska Railroad Corporation own most of the land for the fish passage project, to include the staging area. An easement may also have to be obtained from a private property owner for access to the utility lines. The MOA and/or the ADOT&PF own the land where the separator would be installed.

4.9 Public Involvement

Interest in restoring the aquatic habitat in Chester Creek has been discussed since the early 1970s. In the late 1980s, the MOA did its first detailed study in to how to improve fish passage at

Westchester Lagoon. In the mid 1990s, the Chester Creek Watershed Forum, a citizen-based group, was formed. The forum was part of the MOA Watershed Management Program. The forum identified habitat and water quality related issues within the watershed. In 1999, the Corps of Engineers became involved in the restoration of the creek through the Section 206 program.

In the summer of 2000, presentations were made to eleven community councils within the Chester Creek watershed. The purpose of the presentations was to announce that the project was underway, describe what would be happening during the project, and solicit input from people attending. In the summer of 2002, presentations were made to the three community councils most directly affected by the fish passage project—Turnagain, Spenard, and South Addition. South Addition had the greatest concerns and wanted more information, related primarily to parking and increased use of the area. In August 2002, concept approval was obtained from the MOA Department of Parks & Recreation.

During the plans and specifications phase, and during construction, presentations to area community councils will be given. The purpose will be to keep the public informed of design and schedule changes, and to address their concerns. In addition, informational displays will be setup near the construction site and on the pedestrian trail.

4.10 Coordination with Other Agencies

This study has been coordinated with all relevant State and Federal agencies, including the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, and the Alaska Department of Fish and Game. The U.S. Fish and Wildlife Service has provided support and input for the design of the project and is also providing funding for the implementation of the recommended plan. This project has also been coordinated with the Alaska Railroad Corporation and the Municipality of Anchorage.

4.11 Environmental Compliance

An environmental assessment was prepared and circulated for public review in June 2001. Agency comments have generally supported the project's priorities and design. Only one public comment was received, and the comments were taken into consideration. A Finding of No Significant Impact for the project was signed on November 19, 2001. In addition, a public notice for Section 401 of the Clean Water Act was circulated, and the Alaska Department of Environmental Conservation issued a Certificate of Reasonable Assurance on August 3, 2001. A revised Certificate will be requested. The Alaska Division of Governmental Coordination found the project consistent with the Alaska Coastal Management Plan and issued a final consistency determination. A Coastal Zone Management consistency determination will be required again for the recommended plan. Further alternative development resulted in the need for another environmental assessment, 404 (b)(1) analysis under the Clean Water Act, and a public interest review period. The dates for the environmental actions for this project are listed in table 11 below.

Table 11. Environmental Compliance Table

Action	Date
FONSI Signed	
ESA Sec. 7 Concluded	
CZM Consistency Determination	
401 Certification	
404 r Certification	
404(b)(1)	
Sec 103 MPRSA Eval	
Sec 106 NHPA (SHPO and/or ACHP	
USFWS Coord. Act Rpt.	
Clean Air Act	

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The studies in this report indicate that Federal construction of the restoration improvements on Chester Creek is justified and complies with appropriate guidance and regulation. The Municipality of Anchorage is willing to act as the local sponsor for the project and fulfill all the necessary local cooperation requirements. Thus, it is concluded that the recommended plan for constructing an open channel with a culvert with the required appurtenances should be pursued by the United States in cooperation with the Municipality of Anchorage.

5.2 Recommendation

I recommend that the environmental restoration project at Chester Creek, Anchorage, Alaska, be approved to proceed to the preparation of plans and specifications, and for construction generally as described as the recommended plan in this report.

Prior to construction, the local sponsor agrees to the following:

A. Provide all lands, easements, rights-of-way, dredged material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project.

B. Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project, except for damages due to the fault or negligence of the United States or its contractors.

C. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses, incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20.

D. Operate, maintain, rehabilitate, repair, and replace all the works after completion in accordance with the regulations prescribed by the Secretary of the Army.

E. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the proposed restoration project. However, for lands that the Government determines to be subject to *navigation servitude*, only the Government shall perform such investigations unless the Federal Government provides the non-federal sponsor with prior specific written direction, in which case, the non-federal sponsor shall perform such investigations in accordance with such written direction.

F. Assume complete financial responsibility, as between the Federal Government and the non-federal sponsor, for all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the general navigation features.

G. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

H. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

I. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

J. Provide, during the period of construction, a cash contribution and/or in-kind services equal to 35 percent of the total cost of pre-construction engineering and design, and construction, or total implementation costs of a multiple purpose project allocated to ecosystem restoration. Pay all costs beyond the Federal limit of $5,000,000 for Section 206 projects.

K. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government.

The recommendations for implementation of environmental restoration at Chester Creek, Anchorage, Alaska, reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect the program and budgeting priorities inherent in local and State programs or the formulation of a national civil works water resources program. Consequently, the recommendations may be changed at higher review levels of the executive branch outside Alaska before they are used to support funding.

Date:________________

TIMOTHY J. GALLAGHER
Colonel, Corps of Engineers
District Engineer

6.0 LITERATURE CITED

Alaska Community Database. Alaska Department of Community and Economic Development. <http://www.dced.state.ak.us/cbd/commdb/CF_BLOCK.cfm>

Brabets, T.P. 1987. Quantity and quality of urban runoff from the Chester Creek Basin, Anchorage, Alaska. Prepared in cooperation with the Municipality of Anchorage. Anchorage, Alaska. U.S. Dept. of the Interior, Geological Survey. Denver, Colo.

Corwin & Associates, Inc. "Chester Creek Water Quality Study and Improvement Investigation." November 1987.

Davis, J.C. and Muhlberg. 2001. Chester Creek stream condition evaluation. Alaska Department of Fish and Game, Habitat Restoration Division, Technical Report No. 01-7, Anchorage.

HDR Alaska, Inc. Memorandum To Westchester Lagoon Fish Passage File, Subject: Effects of Altered Flooding Regime on Project Area Vegetation. August 1996.

HDR Engineering, Inc. "Chester Creek 92-16, Conceptual Design Report." 1993.

Hogasen, H.R. 1998. Physiological changes associated with the diadromous migration of salmonids. Canadian Special Publication of Fisheries and Aquatic Sciences 127. 128p.

Oregon Department of Fish and Wildlife, "Guidelines and Criteria for Stream-Road Crossings." <http://www.dfw.state.or.us/ODFWhtml/InfoCntrFish/Management/stream_road.htm>

U.S. Army Corps of Engineers, Alaska District. June 2001. Environmental Assessment and Finding of No Significant Impact, Aquatic Ecosystem Restoration, Chester Creek, Anchorage, Alaska.

U.S. Fish and Wildlife Service, Division of Ecological Services. 1981 Ecological Services Manual. Habitat Evaluation Procedures (Parts 100-199).

7.0 DRAWINGS