**U.S. Army Corps**
**of Engineers**
Seattle District

# Carpenter Creek Estuary
# Section 206 Restoration Project

## Kingston, WA

## DRAFT Integrated Feasibility Report and Environmental Assessment

**Original draft September 2003, updates incorporated January 2005**

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# 1. INTRODUCTION

## 1.1 Study Authority

This Integrated Feasibility Report and Environmental Assessment is submitted under the continuing authority of Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303), as amended. This continuing authority program allows the United States Army Corps of Engineers (USACE) to carry out aquatic ecosystem restoration and protection projects if the project will improve environmental quality, is in the public interest and is cost effective. The federal share of the costs for any one project may not exceed $5,000,000.

On June 29th, 2001, the Kitsap County Department of Community Development submitted a letter to the Seattle District USACE requesting federal assistance in restoring fish and wildlife habitat in Carpenter Creek estuary, located in Kitsap County, Washington. Washington State Department of Fish and Wildlife (WDFW), Stillwaters Environmental Education Center, the Suquamish Tribe, and various private landowners in the area have also submitted letters in support of the project. Copies of the sponsor and stakeholder letters are included in Appendix A of this report.

## 1.2 Study Purpose and Scope

Carpenter Creek estuary is a moderate sized estuary, providing more than 30 acres of high quality habitat in a crucial location in eastern Puget Sound for migrating salmonids. As seen in Figure 1, Carpenter Creek estuary is connected to the Puget Sound through Appletree Cove. The purpose of this feasibility study is to evaluate restoration opportunities that will allow unimpeded juvenile salmonid access to the estuary and provide additional restoration of natural processes. The main project objectives are: (1) to restore natural tidal hydrologic fluctuations in the estuary; (2) reclaim some of the historic intertidal habitat and salt marsh habitat by removing fill material; (3) remove fish passage barriers (high-velocity culvert openings and perched culverts); (4) eliminate localized scour problems and reduce depositional problems; and, (5) reduce the fragmentation of shoreline and upstream habitats and environments.

The purpose of the Carpenter Creek Estuary Restoration Project aligns well with the regional restoration goals of reducing watershed/estuary/shoreline fragmentation, which has contributed to the decline of the Puget Sound chinook salmon population (Harring 2000). The restoration measures inherent in this project would ultimately increase the estuarine and shoreline habitat areas used by Puget Sound chinook salmon (listed as threatened under the Endangered Species Act), and a variety of other anadramous fish species, including coho, chum, sea-run cutthroat and steelhead trout. Additionally, restoration activities would restore the natural processes of tidal hydrology, sediment transport, and detritus exchange that are essential for maintaining high quality estuarine habitats.

## 1.3 Project Location and Background

The project is located in the Carpenter Creek/Appletree Cove estuary, near the unincorporated community of Kingston, which is located in northern Kitsap County, Washington (**Figure 1**). The project area is located in and around Appletree Cove, approximately 0.5 miles west of the Port of Kingston. Several small streams, including Carpenter Creek, drain into the estuary and then to the Puget Sound (**Figure 2**). The Carpenter Creek estuary has been identified as a key pocket estuary for juvenile salmonid smolt outmigration to the Pacific Ocean, because of its location at the tip of the Kitsap Peninsula en route to the Strait of Juan de Fuca.

Estuaries are extremely important rearing areas for juvenile salmon; both as a transition between freshwater and saltwater and for their highly productive feeding areas, which include several diverse habitats ranging from the intertidal mudflats to the upper salt marsh and freshwater tidal channel and wetland habitats. Salmon smolts, especially chinook, chum, and pinks, migrating to the Pacific Ocean, utilize the food sources found in the estuarine environment, which has a detritus based food web containing eelgrass beds, mudflats and salt marshes (Harring 2000). In addition, a range of salmonid and other marine species utilize the protective cover found in estuaries including blind channels, overhanging riparian vegetation and large woody debris.

Several activities have led to the degradation of the Carpenter Creek / Appletree Cove estuary. The construction of several road embankments has significantly fractured the estuary. The culverts that were constructed through these road embankments are undersized for the tidal hydrology, and therefore reduce tidal exchange within the estuary. Habitat degradation has therefore resulted from filling of intertidal areas with road embankment materials, and from the alteration of the tidal hydrology, which ultimately influences changes in estuary morphology and vegetation characteristics.

Historically, the mouth of the estuary, now buried under South Kingston road fill, extended from Arness Park (previously a sand spit) to the north Appletree Cove shoreline. Figure 3 shows a 2002 aerial photograph of the Carpenter Creek estuary. The estuary was likely connected to Appletree Cove through a primary drainage channel with intertidal vegetation in the channels or along the mud flats, and salt marsh vegetation near the edges of the mean high tide stage that provided fishery and macroinvertebrate habitat.

The original date of the construction of South Kingston Road is unknown. Prior to 1958, however, the roadway profile across the mouth of the estuary was slightly lower than currently exists, and a 150-foot span timber bridge, with vertical supports at 10-feet on center, was in place, and was centered approximately where the current box culvert is located (Kitsap County 1958).

In 1958, the timber bridge was demolished and the roadway was filled and raised to the profile that currently exists. A 10-foot high by 10-foot wide box culvert was installed through the roadway fill, and represented the sole connection between Appletree Cove and the Carpenter Creek estuary. For several years immediately following the installation of the box culvert, WDFW used the culvert as a means of controlling flow in and out of the estuary, and subsequently used the estuary as a rearing facility for juvenile coho. After several years, the operation was terminated (personal communication with Jack Minert 2002). The current connection between Appletree Cove and the Carpenter Creek estuary remains as the 10-foot by 10-foot box culvert.

Within the upper Carpenter Creek estuary lobe (upstream of West Kingston Road), there is an abandoned roadbed that buries historic intertidal areas. Salt marsh and intertidal mudflat habitat were the likely habitat types that existed before the construction of the roadbed. Other notable changes in the upper lobe of the estuary include shifts in salt marsh vegetation composition and channel morphology (Cutthroats *et al.* 2001), both of which are attributed to the presence of the constriction at the mouth of the estuary.

## 1.4 Resource Problems

There are several adverse effects on tidal hydrology, tidal hydraulics and estuarine morphology resulting from the undersized culvert at South Kingston Road. First, due to the flow constriction, large scour holes have developed both upstream and downstream from the culvert. The scour holes are a combined result of jet scour and contraction scour, which have been caused by the high magnitudes of velocity exiting the culvert and the narrowing of the effective flow width, respectively. Scour holes of this magnitude are not typically found in natural estuarine channel morphology, and have been observed to strand fish during low tides. Second, the flow constriction causes high velocities during both flood and ebb tides, with magnitudes exceeding 10 feet per second (fps) during average tidal conditions. Velocities of this magnitude act as a fish passage barrier, especially for juvenile salmonids attempting to enter the estuary during ebb tides. Finally, the constriction also reduces the volume of the tidal prism, and dampens tidal peaks, ultimately reducing upstream estuarine habitat area, changing the historic sedimentation and morphologic characteristics of the estuary, and reducing the tidal channel drainage network.

As seen in Figure 3, the mouth of the upper lobe of the Carpenter Creek estuary is currently buried under the West Kingston Road fill, and is connected to the main lobe of the estuary through a 60-inch diameter concrete culvert. Prior to construction of the West Kingston Road culvert, the upper lobe of the Carpenter Creek estuary was likely connected to the main lobe through a secondary tidal and freshwater drainage channel with intertidal mud flats and salt marsh vegetation near the edges of the mean high tide stage that provided fishery and macroinvertebrate habitat. There are several adverse effects that have resulted from the circular culvert, although they are less apparent than those resulting from the South Kingston Road culvert. First, the downstream end of the culvert is perched approximately 6-inches. The second adverse effect is related to the resulting changes in estuary morphology immediately upstream from the West Kingston Road culvert. This area is the transition between the intertidal mudflats and the upper salt marsh environment. Deposition of fine sediments is occurring on the upstream flanks of the culvert, due in part to the presence of ineffective flow areas immediately upstream of the inlet to the culvert. Historically, this upper lobe of the estuary was exposed to greater flow exchange, which more effectively flushed sediments and organic materials. Instead, the area now experiences ineffective/stagnant flows where sediment deposition of fine materials occurs. The tidal channel network in this area has also been reduced and marsh habitat has increased. Reduction in tidal inundation has also resulted in a conversion of salt marsh to freshwater marsh, which are being colonized by invasive, exotic plant species.

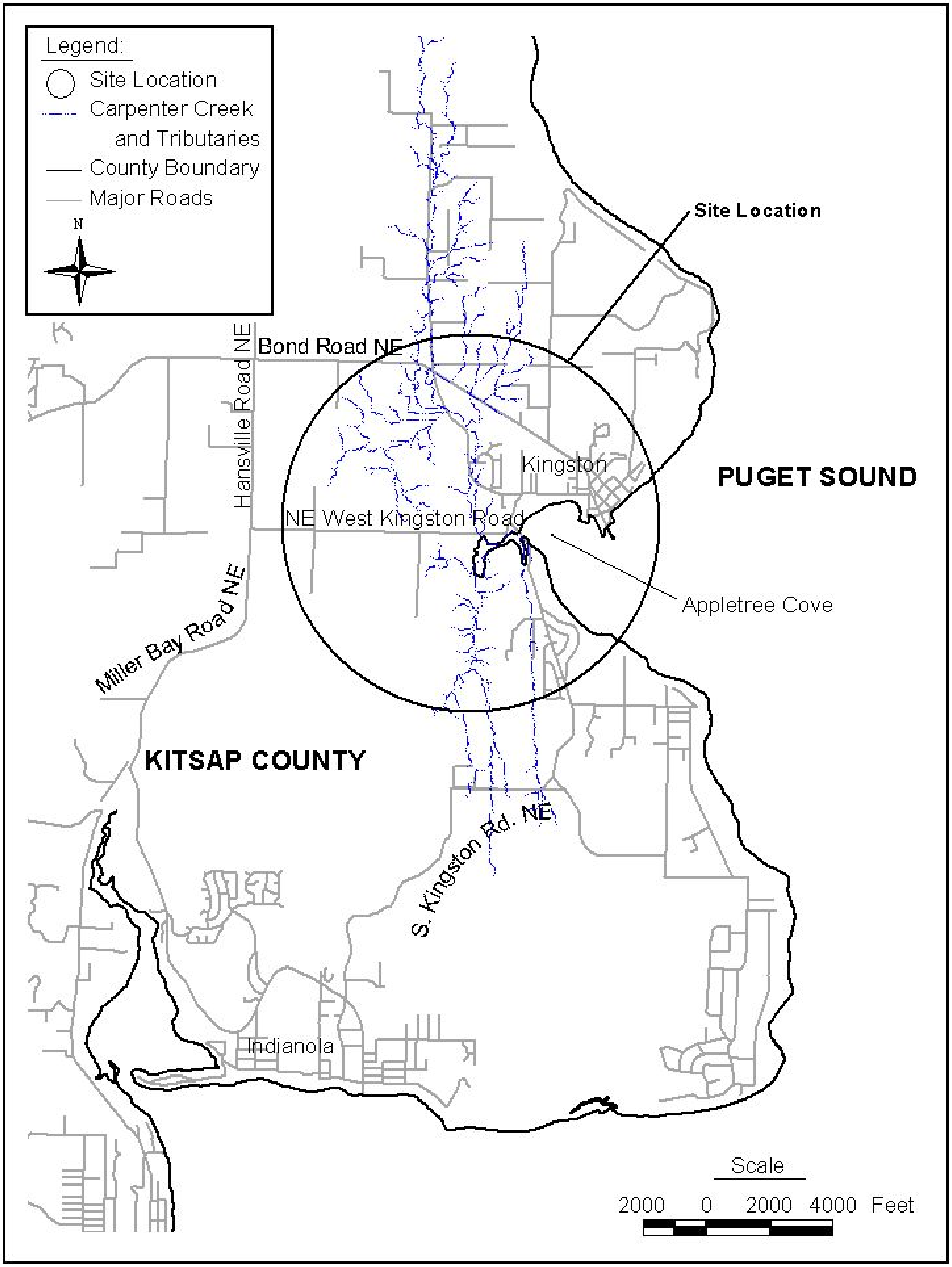


**Figure 1. Site Map**

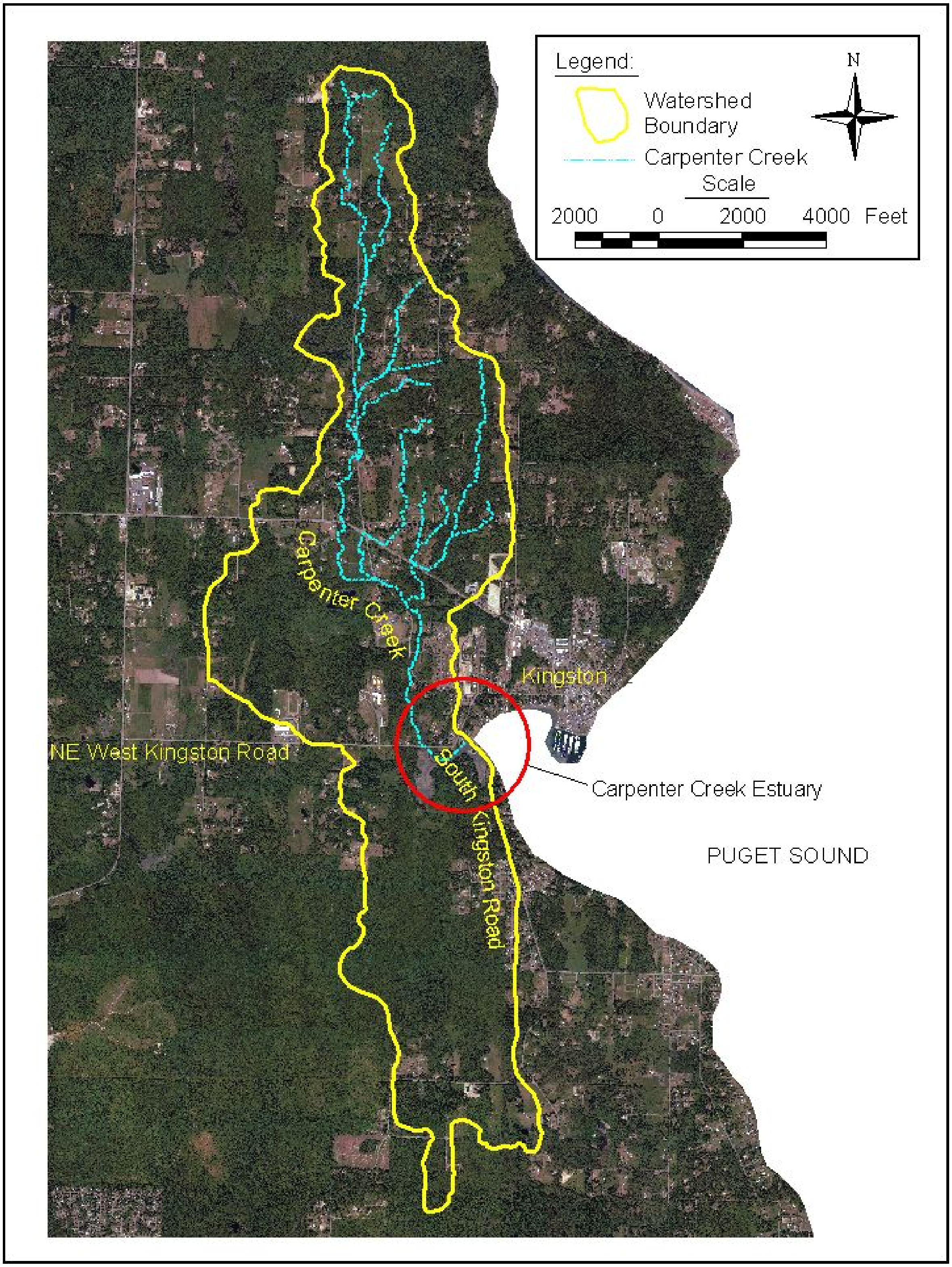


**Figure 2. Watershed Map**

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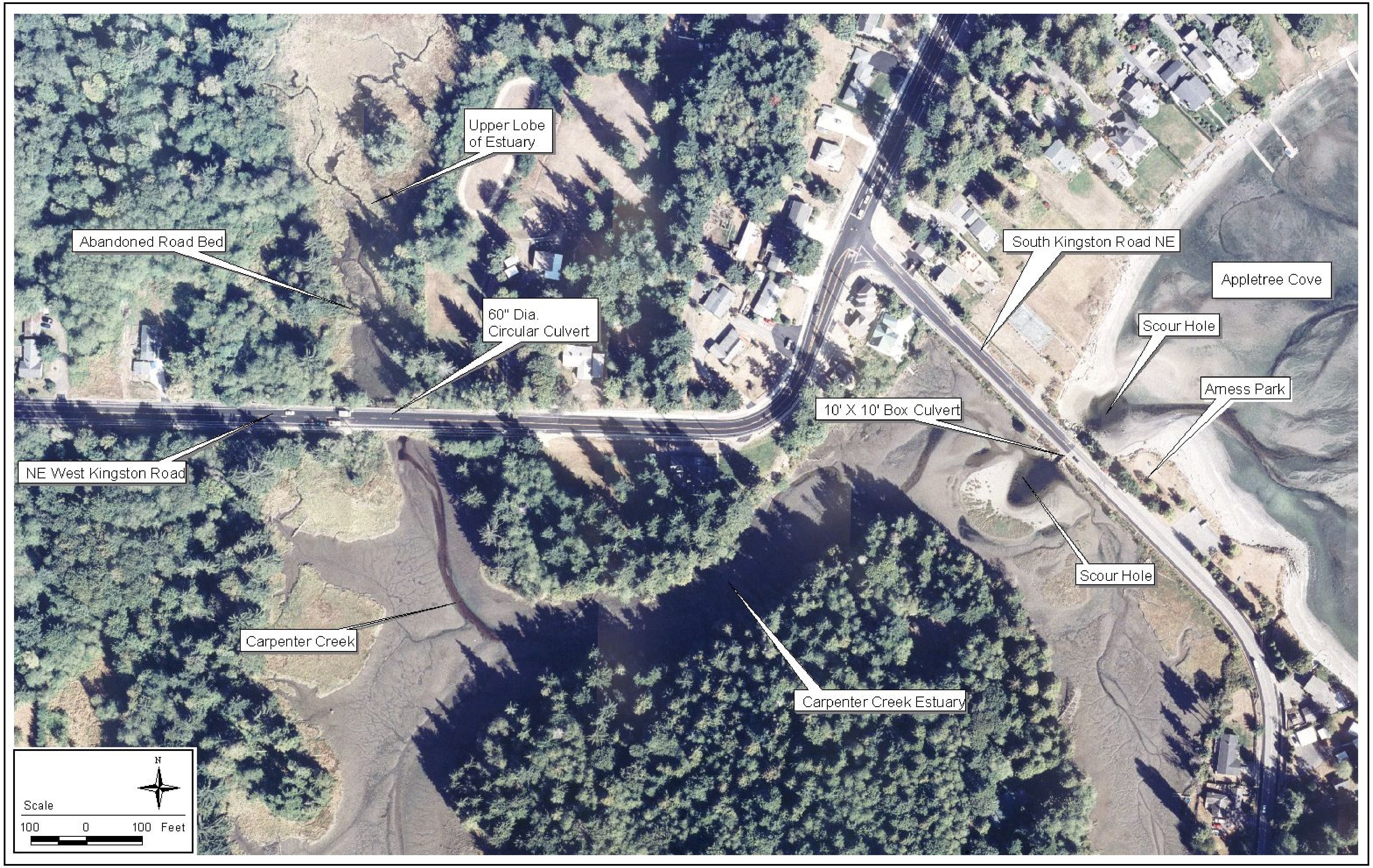


**Figure 3. Project Area**

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## 1.5 Prior Studies and Reports

The Carpenter Creek Section 206 project was initiated in response to a request for assistance in a letter dated 26 June 2001 from the Kitsap County Department of Community Development. Later in 2001, the Seattle District USACE prepared a Preliminary Restoration Plan (PRP) for the Carpenter Creek Estuary (USACE 2001a). The PRP provided an overview of the project location, description, historic, current and future conditions, project alternatives, costs/benefits, financing obligations, sponsorship views and a preliminary project schedule. As follow-on to the PRP, the Seattle District prepared a Draft Fact Sheet (Tetra Tech 2002), which provided a more detailed evaluation and analysis of the alternative restoration measures that were outlined in the PRP.

The Stillwaters Environmental Education Center is a community supporter of the restoration project and has developed a watershed planning report (Cutthroats *et al.* 2001). The report is an overview document that references a majority of all studies to date related to the Carpenter Creek Estuary/Appletree Cove ecosystem and the Carpenter Creek watershed. The report highlights issues, topics, concerns and needs for restoration work within the watershed. The watershed report also contains a comprehensive bibliography of related reports for Carpenter Creek and Appletree Cove.

Another important resource is the "*Salmonid Habitat Limiting Factors: Water Resource Inventory Area (WRIA)-15*" report that identifies limiting factors within the Carpenter Creek Estuary/Appletree Cove system and fish barrier and sedimentation issues in the vicinity of West Kingston Road. The report further recommends that the greatest restoration potential within WRIA-15 is in the larger stream systems, including Carpenter Creek.

## 1.6 Future Without Project Conditions

The morphology of the Carpenter Creek estuary has been continually adjusting to the anthropogenic alterations that have occurred both within the estuary itself and within the Carpenter Creek watershed. This process of adjustment will continue in the future, characterized by limited export of sediment and detritus from the upper lobe of the estuary (upstream of West Kingston Road), and continued conversion of mudflat areas to marsh habitat; however, the adjustment to the alterations within the estuary will likely proceed more slowly in the future since the estuary has been evolving towards a new equilibrium throughout the last fifty years.

Fish movement in and out of the estuary will continue to be limited during all tide cycles, due to the high velocities through the South Kingston Road culvert. A more detailed discussion of the future without project conditions is presented in the section of this report that addresses the environmental impacts of the no action alternative and the recommended alternative (Section 6).

## 1.7 Expected Success

The proposed restoration project would restore natural processes and functions that will benefit salmonid species. The project would address some of the anthropogenic alterations that have

adversely affected the processes that influence biologic habitat composition and habitat function; namely estuarine hydrology, local hydraulics, and geomorphology.
Replacing the culvert at South Kingston Road with a bridge structure that has a wider horizontal opening dimension, and roughly the same vertical opening dimension, as the existing condition opening, would restore the natural hydrologic characteristics at the inlet to the estuary. The natural hydrologic and transport characteristics within the estuary would be improved by replacing the culvert at West Kingston Road with a bridge structure with larger vertical and horizontal dimensions than the existing culvert.

At mean high water (MHW), the available cross section through the South Kingston Road embankment will be increased from approximately 75 square feet to 360 square feet. This nearly five-fold increase in area at the mouth of the Carpenter Creek estuary will allow more tidal volume to be conveyed in and of the estuary, and would result in increased improvements in sediment and detritus exchange between Appletree Cove and Carpenter Creek estuary.

By replacing the culvert at West Kingston Road with a clear span bridge, the primary improvement to the estuary will be improved sediment and detritus exchange between the upper and lower lobes of the estuary. The existing culvert through the West Kingston Road embankment acts as a hydraulic restriction, which does not allow for proper flushing of sediment derived from the upper Carpenter Creek watershed. Additionally, a valuable wildlife corridor will be established through the West Kingston Road embankment, where one does not currently exist.

Local hydraulic conditions at South Kingston Road would also be improved with the larger opening. The scour holes, which have developed as a result of the installation of the box culvert, would be filled and the hydraulic conditions that led to their development would be eliminated. Average cross sectional velocities through the opening would be significantly reduced, thereby allowing unhindered movement in and out of the estuary for anadramous fish species.

In addition, the restoration effort would improve the geomorphic composition of the tidal drainage networks. Channels located in the upper estuary that are actively filling with fine sediment and that are converting to marsh habitat, would be restored as a result of improved tidal flushing. The project will restore a natural hydrologic regime to the estuary, and will restore the natural formation of tidal channels and other estuarine habitats.

Additional habitat functioning will be restored through the planting of native riparian species that will provide cover, nesting, perching and foraging for fish and wildlife species.

Habitat area will also be increased through the removal of an abandoned road embankment and the replacement of the perched West Kingston Road culvert. These measures will provide more area and a greater period of access to the estuary. In addition, the combination of work on historic tidal channels and riparian plantings will provide for increases in usable fishery habitat areas and improve the natural processes that promote healthy habitat functions of the estuary.

The proposed project will provide significant benefits to a wide variety of wildlife species. The riparian plantings will provide additional cover and habitat for both fish and wildlife species.

Replacement of existing culverts with single span bridges on both South Kingston and West Kingston roads will provide migratory corridors for mammals as well as improving fish passage. Overall, the project will significantly enhance the quality of habitat in the Carpenter Creek estuary and will provide nearly unlimited access for salmon species.

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# 2. AFFECTED ENVIRONMENT

## 2.1 Geology and Soils

The project site is located in the Puget Lowland, and parent materials in the project area are primarily glacial till. A review of available geologic information indicates that subsurface conditions in the project area are the result of several episodes of interglacial erosion, scour by glaciers, deposition of glacial and non-glacial sediments, and post-glacial deposition and erosion. Erosion and deposition during and following glaciation have resulted in the modern topography of the Puget Lowland. Deposits associated with the most recent glaciation include advance outwash, till, and recessional outwash. (GeoEngineers 2002).

Soils mapped in the project area include beach deposits, Sinclair very gravelly sandy loam (till), Norma fine sandy loam and Ragnar fine sandy loam (from glacial alluvium and outwash) and Tacoma silt loam (more recent alluvial deposits from Carpenter Creek) (SCS 1980). In general, the geologic units that were observed at the site consist of road embankment fill, recent beach deposits and recent alluvium. The beach deposits are generally mapped as spits and consists of sand and gravel and may include silt and shell fragments (GeoEngineers 2002).

In October 2002, subsurface conditions at both road crossings were evaluated by drilling two borings at each site. The borings were field located to correspond with the anticipated locations of the proposed bridge/culvert foundations. At South Kingston Road, the borings were extended to depths of 54 feet and 59 feet below the road surface. Fill was encountered in each of the borings at South Kingston Road to a depth of approximately 19 feet below the roadway surface. Beach deposits, consisting of loose to medium dense sand and gravel with silt and shell fragment content, extended to a maximum depth of approximately 45 feet below the road surface. The two borings were terminated in the Whidbey Formation, interbedded layers of dense to very dense silty sand with occasional gravel and hard silt, at depths of approximately 54 feet and 59 feet (GeoEngineers 2002).

At West Kingston Road, both borings were extended to a depth of 34 feet below the road surface. Fill was encountered in the two borings to respective depths of 7 and 11 feet. The fill was underlain by recent alluvium, comprised of very loose sand with variable silt content and organic matter, to respective depths of 12 feet and 15 feet. In the one of the borings, glacial till was observed below the alluvium to a depth of approximately 21 feet. The two borings were terminated in the Whidbey Formation, interbedded layers of medium dense to very dense silty sand with occasional gravel and hard silt, at depths of approximately 34 feet below the roadway surface (GeoEngineers 2002). Refer to Appendix B for the complete Preliminary Engineering Services Report.

## 2.2 Geomorphology and Sedimentation

The estuary is composed of salt marsh, intertidal mudflats and a series of 3$^{rd}$ and 4$^{th}$ order tidal/freshwater drainage channels (Levy 1981) that completely dewater during lower tides (see Figure 4). The morphologic composition of the estuary channels range from a slightly sinuous (sinuosity = 1.15), primary drainage in the mudflat areas to a series of more sinuous (sinuosity =

1.3), narrower, dendritic channels in the upper estuary, upstream of West Kingston Road. The upper estuary maintains an average gradient of 0.26 percent (0.0026 ft/ft) with top widths of approximately 5 to 6 feet and the estuary channel banks are composed of mud with salt marsh vegetation at the top of bank. The lower estuary, between West Kingston and South Kingston Roads has an average gradient of 0.069 percent (0.00069 ft/ft) with average top widths of approximately 15 to 18 feet and the channel banks gradually grade into sandy/silty mudflats with small areas of eelgrass present (*Zostera marina* and *Z. japonica*) as well as macroalgae. Eelgrass was observed during field reconnaissance visits in November 2002.

**Figure 4. Carpenter Creek Looking Upstream from South Kingston Road**

The culvert constrictions have caused sediment deposition upstream of West Kingston Road and localized scour upstream and downstream of South Kingston Road. This has altered the natural tidal channel formation process and reduced tidal channel area. The upper estuary is currently transforming from a predominately saltwater marsh into a combination of saltwater/freshwater emergent marsh through reduction of saltwater inundation and flushing flows, both of which have contributed to the infilling of the drainage channels with sediments and salt marsh vegetation. Figure 5 is a photograph of the upper lobe of the estuary, looking downstream towards West Kingston Road. The figure illustrates the deposition that has occurred upstream of this restrictive culvert, and the subsequent evolution of emergent species within the mudflat environment.

Figure 6 shows a comparison of aerial photographs taken in 1957 and in 2002. The 1957 photograph clearly shows the timber bridge structure at South Kingston Road.

**Figure 5. Carpenter Creek Looking Downstream Towards West Kingston Road**

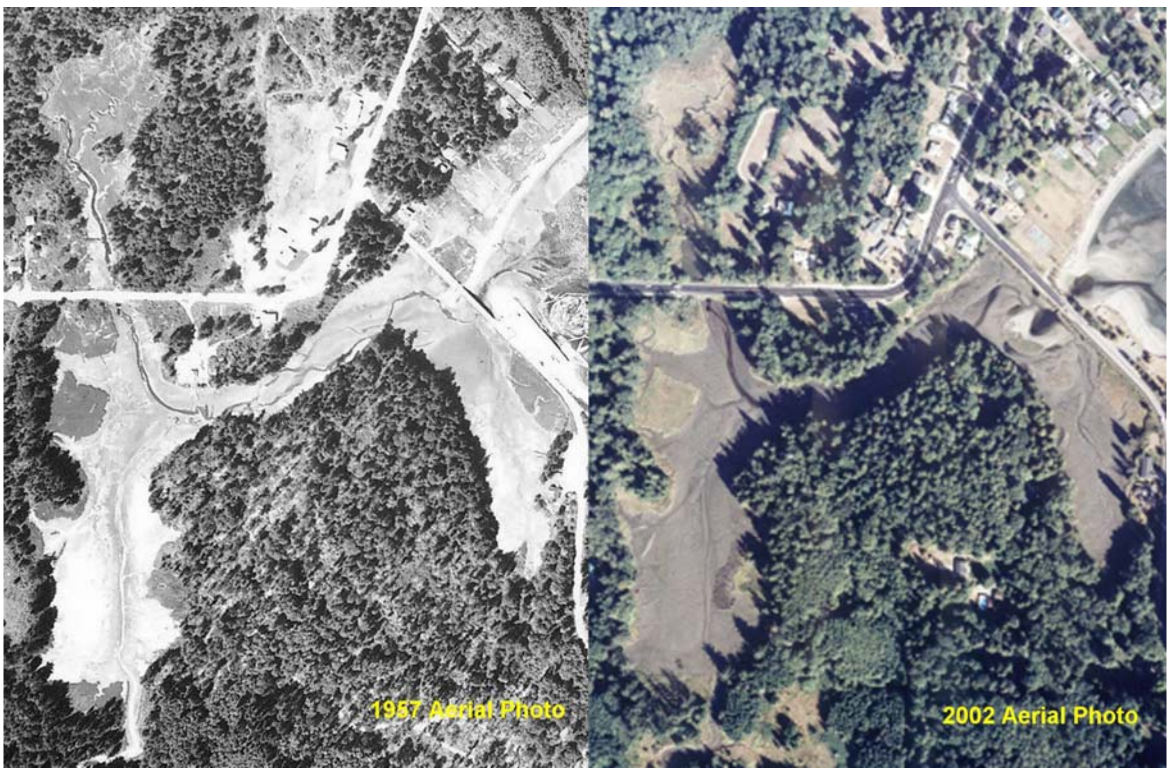


**Figure 6. 1957 Historic and 2002 Current Aerial Photographs**
(Approximate scale 1” = 600’)

## 2.3 Hydrology and Hydraulics

Hydrologic influences in the estuary are dominated by tidal fluctuations, which are characterized by a diurnal inequality (successive high and low tides have different elevations). Mean higher high water (MHHW) at the Kingston/Appletree Cove tidal station is 10.99 feet. Mean high water (MHW) and mean tide level (MTL) are 10.14 feet and 6.48 feet, respectively. These elevations are expressed relative to the MLLW tidal datum. The project datum is the NAVD88 geodetic datum. Conversion of elevations from MLLW tidal datum to NAVD88 geodetic datum is accomplished by subtracting 2.28 feet from the MLLW elevations. Table 1 shows the tidal elevations relative to both datums.

**Table 1. Tidal Elevations Relative to MLLW Tidal Datum and NAVD88 Geodetic Datum**

| Tidal Elevation | MLLW (Tidal Datum) | NAVD88 (Geodetic Datum) |
|---|---|---|
| MHHW | 10.99 feet | 8.71 feet |
| MHW | 10.14 feet | 7.86 feet |
| MTL | 6.48 feet | 4.20 feet |
| MLW | 2.82 feet | 0.54 feet |
| MLLW | 0.00 feet | -2.28 feet |

Contributions of freshwater inflow primarily come from Carpenter Creek, with secondary contributions from two unnamed creeks that enter the estuary from the south. The combined tributary drainage area at the mouth of the Carpenter Creek estuary is approximately 3.5 square miles. There is no gauged flow data for these tributary creek systems; therefore, peak flow magnitudes for a range of return frequencies were estimated using numerical modeling and analytical methods. Existing condition 2-year and 100-year flow rates, from the Carpenter Creek watershed, were estimated to be 33 cfs and 131 cfs, respectively.

The existing culvert invert elevations are 2.75 feet and 5.41 feet (NAVD88) at South Kingston Road and West Kingston Road, respectively. Therefore, as seen in Table 1, tidal inundation upstream of West Kingston Road does not occur at the mean tidal elevation. On two separate occasions in October 2002, water levels were observed and recorded at the upstream and downstream sides of the two culverts. Water level observations were documented to support modeling efforts of estuary hydraulics. As seen in Figure 7, the observations indicated that the damping effect of the South Kingston Road culvert is more significant than that of the West Kingston Road culvert. The South Kingston Road culvert appears to cause a slight time lag on the arrival of the peak upstream of West Kingston Road. During ebb tides, the water surface elevations in the estuary subside at a slower rate than those observed within Appletree Cove (downstream of the South Kingston culvert), indicating that the culverts are inhibiting the natural outflow drainage characteristics of the estuary.

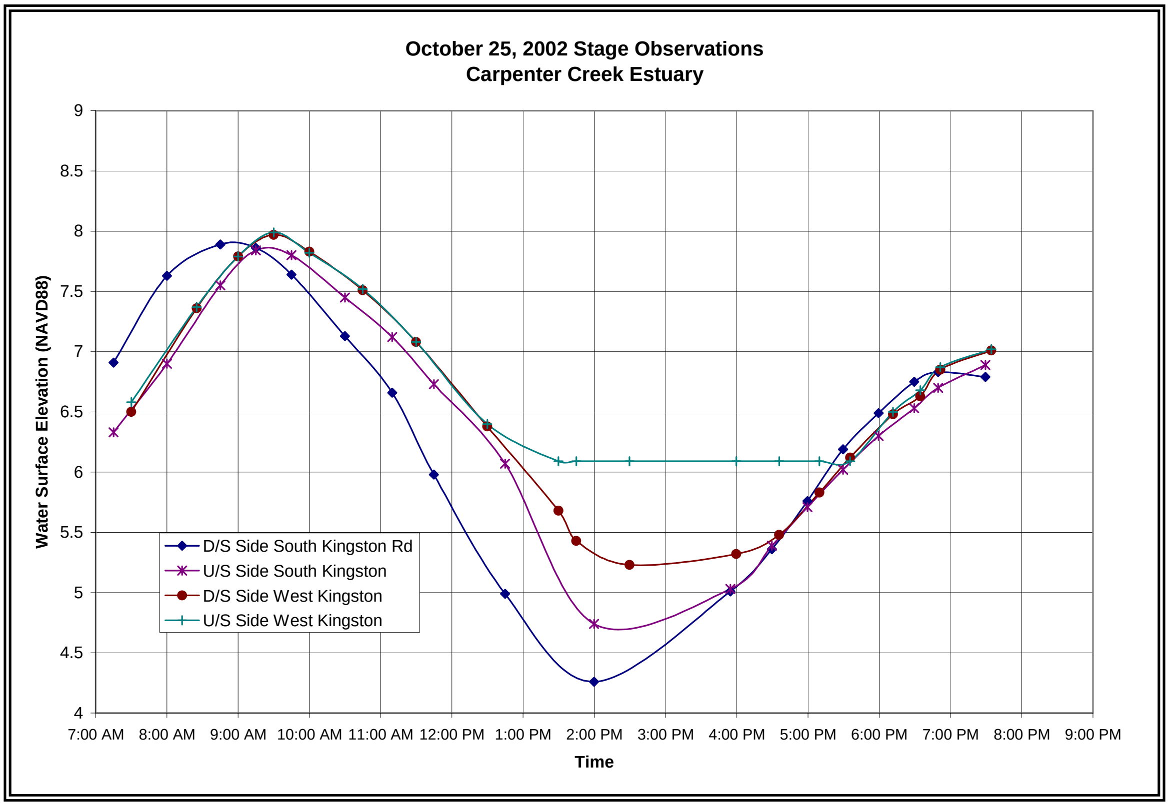


**Figure 7. Water Level Observations – October 25th, 2002.**

To establish the baseline hydraulic conditions in the estuary, an average tidal cycle was identified using the 2002 tide charts as the primary reference. The daily tide cycle that most closely matched the MHHW and MHW tide elevations summarized in Table 1 was selected to represent the average tidal cycle. Using this process, several candidate daily tide cycles were identified; however, the August $12^{th}$ tide cycle provided the closest match to the statistics presented in Table 1. To include more than one complete tide cycle in the hydraulic analysis, the preceding day and the two subsequent days were included. Therefore, the average tide cycle was defined from 0000 hours on 8/11/02 through 0300 hours on 8/14/02. The average tide cycle is shown in Figure 8.

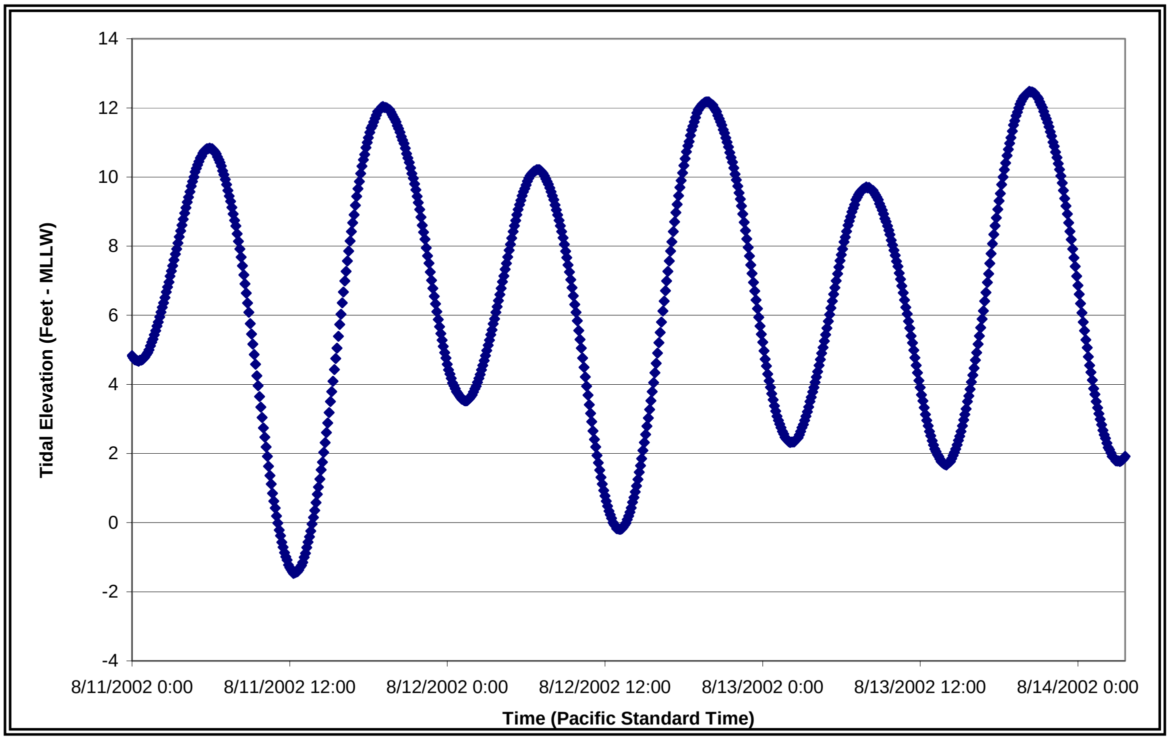


**Figure 8. Average Tide Cycle**

The results of the baseline hydraulic analysis indicated that ebb tide velocities through the South Kingston Road culvert attained magnitudes greater than 10 ft/s during the average tide cycle. The velocity that was exceeded 50% of the time during the average tide cycle was estimated to be between 2.5 and 4 ft/s. For nearly 75% of the tide cycle, the average velocity through the culvert opening was equal to or exceeded 1 ft/s.

The West Kingston Road culvert was found to have significantly lower velocities during the average tide cycle, due mostly to the fact that flow rates generated by the tides are a nearly an order of magnitude lower than those through the South Kingston Road culvert. Figure 9 shows the velocity exceedance curves for both of the existing culvert openings during the average tide cycle.

Appendix C contains the hydrologic/hydraulic data and analysis in support of the project. The appendix includes documentation of the hydrologic/hydraulic analysis of the existing conditions and the post-project conditions with the implementation of the recommended alternative. Additionally, the appendix also includes the documentation of the hydrologic/hydraulic analysis in support of the alternative evaluation.

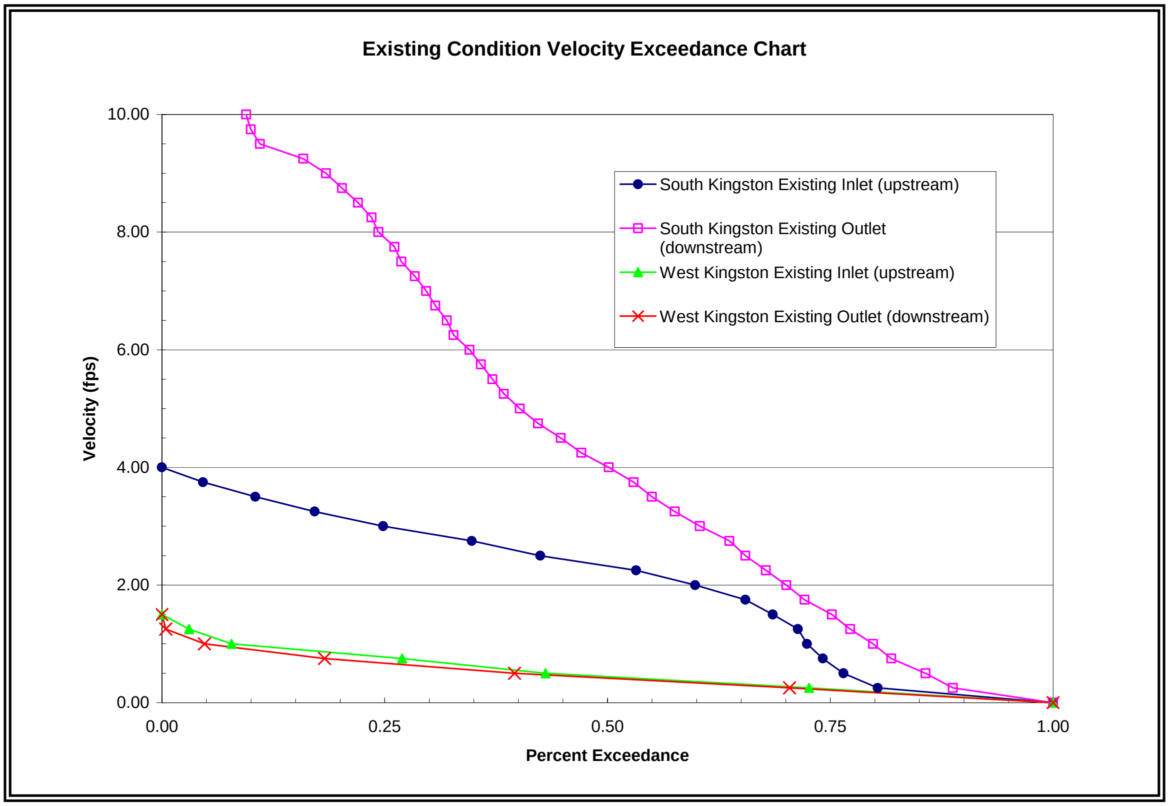


**Figure 9. Velocity Exceedance Curves– Existing Conditions**

## 2.4 Water Quality

Water quality is generally good in Carpenter Creek and its estuary. Carpenter Creek is not listed on the 303(d) list of impaired water bodies. However, several non-point sources are present including septic systems, livestock and roadway runoff. Some limited water quality sampling has occurred in the lake and creek. The lake had low levels of dissolved oxygen (3.8 to 4.2 mg/l in 1996). The Cutthroats of Carpenter have done some water quality monitoring since 2001 in three locations in the creek. Parameters are all within state water quality standards except for occasional high levels of bacteria (up to 300 colonies/100ml), although these levels have apparently been reduced in the last couple of years (Cutthroats *et al*. 2001). Reduction is likely due to repair of some septic systems. No sampling has been done for heavy metals or pesticides.

Water temperature and salinity was measured in November 2002 in the lower creek and estuary as part of the environmental baseline surveys for this project (Tetra Tech staff data 2002). Water temperatures were low during this time of year (7-8° C) and salinity ranged from 5-34 ppt in the estuary (5 ppt at the upper end, 34 ppt at the mouth at South Kingston Road).

## 2.5 Vegetation and Wetlands

Vegetation in the project area varies from forested riparian along the lower creek, to salt marsh, largely unvegetated mud flats, and tidal channels within the estuary itself. The forested riparian zone is dominated by Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), Western red cedar (*Thuja plicata*), red-osier dogwood (*Cornus stolonifera*) and creeping buttercup *(Ranunculus repens*). Non-dominant species include reed canary grass (*Phalaris arundinaceae*), salmonberry (*Rubus spectabilis*) and lady fern (*Athyrium filix-femina*). The tree cover ranged in age from 10 to more than 50 years. Several large cedars are present in this reach of the creek on the Stillwaters Environmental Center property.

A short transition zone of freshwater wetland dominated by creeping bentgrass (*Agrostis stolonifera*), reed canary grass, creeping buttercup and Canada thistle (*Cirsium arvense*) is present where Carpenter Creek flows into the estuary. The freshwater wetland is a very small area of the overall estuary and brackish water is present within 50 feet of the creek channel in standing pools of water (5 ppt salinity). One small patch of cattail (*Typha latifolia*) is present at the creek outlet as well. The brackish marsh area is dominated by creeping bentgrass, along with fat hen (*Atriplex patula*) and salt grass (*Distichlis spicata*). The edge of the upper estuary has a riparian/shoreline buffer of Sitka spruce (*Picea sitchensis*), red alder and ornamental rose (*Rosa eglanteria)*. High salt marsh, dominated by tufted hairgrass (*Deschampsia caespitosa*) and Douglas aster (*Aster douglasii*), is also present in pockets near the edge of the upper estuary. Along the tidal channels in the upper estuary are seaside arrowgrass (*Triglochin maritimum*), salt grass and pickleweed (*Salicornia virginica*).

Downstream of West Kingston Road in the main estuary, high salt marsh is dominated by Douglas aster, seaside arrow grass, and salt grass, with sparser yarrow (*Achillea millefolium*), and dock (*Rumex* sp.). The low salt marsh is dominated by salt grass, pickleweed and fat hen, with sparse gumweed (*Grindelia integrifolia*). Closer to South Kingston Road, vegetation is primarily low salt marsh with more predominant mud flat habitat with sparse macroalgae present (primarily *Ulva*) and the tidal channels have some eelgrass present (*Zostera marina* and *Z. japonica*), as well as macroalgae.

## 2.6 Aquatic Food Web

The altered tidal hydrology within the estuary reduces the productivity of adjacent marine waters, by impairing detritus export and sediment flux from the estuary, as evidenced in the estuary upstream of West Kingston road (**Figure 5**). The low detritus export reduces secondary productivity in Puget Sound, thereby affecting migrating juvenile salmonids by reducing the amount of food available. Natural processes including tidal, sediment and organic exchange are diminished due to the inadequate culvert sizing.

## 2.7 Fish and Wildlife

Fish species present in Carpenter Creek and its estuary include chum and coho salmon, steelhead and cutthroat trout, Pacific lamprey, brook lamprey, stickleback and sculpins (Cutthroats *et al* 2001). Chinook salmon may also be present. Fish passage is restricted at both South Kingston and West Kingston Roads, thus likely limiting the species and numbers of fish that utilize Carpenter Creek and it's estuary. Other fish species that might normally use estuaries include Pacific herring, sculpins, stickleback, surf smelt, shiner perch, sole, sandlance and gunnels (from species captured in the Duwamish estuary and Elliot Bay by Matsuda *et al* 1968 and Warner and Fritz 1995).

Wildlife likely to be present in the Carpenter Creek watershed and estuary include black-tailed deer, black bear, beaver, muskrat, river otter, skunk, bobcat, coyote, voles, chipmunks, mice and raccoon. Birds include bald eagle, peregrine falcon, osprey, kingfisher, great blue heron, great-horned owl, pileated woodpecker, waterfowl such as goldeneye, bufflehead, wood duck, mergansers, mallard, pintail, canvasback, ruddy duck, ringnecked duck, wigeon, Canada geese, teals, coots, cormorants, western grebe, gulls, terns, dunlin, sandpipers, etc. and many songbirds (Cutthroats *et al*. 2001).

## 2.8 Threatened and Endangered Species

A species list was received from the U.S. Fish and Wildlife Service (USFWS) on October 21, 2002. Three listed species may occur in the project area, including bald eagle (*Haliaeetus leucocephalus*), bull trout (*Salvelinus confluentus*), and marbled murrelet (*Brachyramphus marmoratus*).

In May 1999, chinook salmon (*Oncorhynchus tshawytscha*) was included as one of the several species of Pacific salmon that were listed under the federal Endangered Species Act (ESA). The Puget Sound Evolutionary Significant Unit (ESU) of chinook salmon were listed as threatened. An ESU is defined as a distinct group of fish that do not breed with other ESUs due to geographic isolation or run timing.

### *2.8.1 Bald Eagle*

The Washington State bald eagle population was listed as threatened under the Endangered Species Act of 1973, as amended, in February 1978. Since DDT was banned in 1972, bald eagle populations have rebounded throughout the country. The bald eagle was proposed for de-listing in July 1999.

The bald eagle wintering season extends from October 31 through March 31. Winters are spent along lakes, rivers, marshes and seacoasts in much of the United States (AOU 1998). Availability of food is the essential habitat requirement affecting winter numbers and distribution of bald eagles. Other wintering habitat considerations are communal night roosts and perches.

The nesting season for bald eagles is typically between early January and mid-August. The characteristic features of bald eagle breeding habitat are nest sites, perch trees and available prey. Bald eagles primarily nest in uneven-aged, multi-storied stands with old-growth components. Factors such as tree height, diameter, tree species, position on the surrounding topography, distance from water, and distance from disturbance also influence nest selection. Snags, trees with exposed lateral branches or trees with dead tops are often present in nesting territories and are critical to eagle perching, movement to and from the nest, and as points of defense of their territory.

Birds and fish are the primary food source for eagles in Puget Sound, but bald eagles will also take a variety of mammals and reptiles (both live and as carrion) when fish are not readily available (Knight *et al.* 1990). Eagles in tidally influenced habitats also scavenge and pirate more prey than do eagles at rivers or lakes, possibly resulting from expanded feeding opportunities provided by dead and stranded prey on tide flats (Watson and Pierce 1998).

Resident bald eagles occur in the West Kingston and South Kingston Road areas, and they are frequently observed in Appletree Cove and Carpenter Creek estuary when the tide is out. The Washington State Department of Fish and Wildlife Priority Habitats and Species (PHS) Database identifies an active nest along South Kingston Road, within a ½ mile radius of the crossing of West Kingston Road and Carpenter Creek. The nest is close to South Kingston Road, which is a minor collector, connecting the communities of Kingston and Indianola, and is located on a developed waterfront lot (Wiltermood 1999).

Bald eagles utilize the lower estuary between South Kingston Road and West Kingston Road because it is mostly mudflat when the tide is out and is relatively shallow water conditions when the tide is in. They are less frequently seen in the upper estuary, north of West Kingston Road, where there is less mudflat and higher saltmarsh. They typically feed on invertebrates and fish within the cove and the estuary (Wiltermood 1999).

### *2.8.2 Marbled Murrelet*

The marbled murrelet was listed as a threatened species under the Endangered Species Act of 1973, as amended, in October 1992. Primary causes of population decline include the loss of nesting habitat, and direct mortality from gillnet fisheries and oil spills.

Marbled murrelets forage in the near-shore marine environment and nest in inland old-growth coniferous forests of at least seven acres in size. Marbled murrelets nest in low-elevation forests with multi-layered canopies and select large trees with horizontal branches of at least seven inches in diameter and heavy moss growth. Of 95 murrelet nests in North America during 1995, nine were located in Washington. April 1$^{st}$ through September 15$^{th}$ is considered nesting season, however, in Washington marbled murrelets generally nest between May 26$^{th}$ and August 27$^{th}$ (USFWS 1999). Adults feeding young fly between terrestrial nest sites and ocean feeding areas primarily during the dawn and dusk hours.

Marbled murrelets spend most of their lives in the marine environment, where they forage in areas 0.3 to 2 km from shore. Murrelets often aggregate near localized food sources, resulting in a clumped distribution. Prey species include herring, sand lance, anchovy, osmerids, seaperch, sardines, rockfish, capelin, smelt, as well as invertebrates such as euphausiids, mysids, and gammarid amphipods.

Although marine habitat is critical to marbled murrelet survival, USFWS' primary concern with respect to declining marbled murrelet populations is loss of terrestrial nesting habitat. In the marine environment, USFWS is primarily concerned with direct mortality from gillnets and spills of oil and other pollutants (USFWS 1996).

Critical habitat was designated for the marbled murrelet on May 24, 1996 (USFWS 1996). The critical habitat units nearest to the project site are approximately 25 miles away, on the west side of Hood Canal in the Olympic National Forest.

Presence of marbled murrelets in the project area is not well documented, but marbled murrelets may forage in the estuarine areas adjacent to the project.

### *2.8.3 Bull Trout*

The Coastal/Puget Sound bull trout population segment was listed as a threatened species under the Endangered Species Act of 1973, as amended, in October 1999. Bull trout populations have declined throughout much of the species' range. Some local populations are extinct, and many other stocks are isolated and may be at risk (Reiman and McIntyre 1993). A combination of factors including habitat degradation, expansion of exotic species and harvest has contributed to the decline and fragmentation of indigenous bull trout populations.

Bull trout spawning usually takes place in the fall during September and October. Initiation of breeding appears to be related to declining water temperatures. In Washington, Wydoski and Whitney (1979) reported spawning activity was most intense at 5 to 6$^{o}$C. Spawning occurs primarily at night. Groundwater influence and proximity to cover are reported as important factors in spawning site selection. Bull trout characteristically occupy high quality habitat, often in less disturbed portions of drainage, as well as high elevation areas with low water temperatures. Necessary key habitat features include channel stability, clean spawning substrate, abundant and complex cover, cold temperatures, and lack of barriers, which inhibit movement and habitat connectivity (Reiman and McIntyre 1993).

Juvenile bull trout, particularly young of year (YOY), have very specific habitat requirements. Small bull trout are primarily bottom-dwellers, occupying positions above, on or below the stream bottom. Bull trout fry are found in shallow, slow backwater side channels or eddies. The adult bull trout, like its young, is a bottom dweller, showing preference for deep pools of cold water rivers, lakes and reservoirs (Moyle 1976).

Bull trout movement in response to developmental and seasonal habitat requirements make their movements difficult to predict both temporally and spatially. A recent summary paper on bull trout in Stillaguamish Basin (WDFW 1999) provided some general information on bull trout distribution in Puget Sound river basins. Newly emergent fry tend to rear near spawning areas, while foraging juvenile and sub-adults may migrate through river basins looking for feeding opportunities. Post-spawn adults of the non-resident life form quickly vacate the spawning areas and move downstream to forage, some returning to their "home" pool for additional rearing. Anadromous sub-adults and non-spawning adults are thought to migrate from marine waters to freshwater areas to spend the winter.

Bull trout have not been well documented in most basins in Puget Sound; however, based on research in the Skagit Basin (Kraemer 1994), anadromous bull trout juveniles migrate to estuarine areas in the April to May timeframe, then re-enter the river from August through November. Most adult fish enter the estuarine areas in the February to March timeframe, and return to the river from May to June. Sub-adults, fish that are not sexually mature but have entered marine waters, move between the estuarine environments and the lower river environments throughout the year.

Bull trout are not known to occur in Carpenter Creek, and are not likely to be present in these lowland streams because of their habitat requirements for cold temperatures and deep pools. Bull trout may be present in the marine waters adjacent to the project area, and may utilize estuarine areas for foraging.

### *2.8.4 Chinook Salmon*

The majority of Puget Sound chinook are of the ocean-type life history (NMFS 1998). Ocean-type chinook migrate to estuaries during their first year of life, normally within three to six months after emergence from spawning gravel. Growth and development to adulthood occurs primarily in estuarine and coastal waters (NMFS 1998). Ocean-type chinook return to their natal river in the fall, though actual adult run and spawning timing is in response to the local temperature and water flow regimes (Myers *et al.* 1998). Duration of incubation varies, depending on location of redds, but is generally completed by the end of February. Young chinook reside in stream gravels for 2 to 3 weeks after hatching (Wydoski and Whitney 1979) before moving to lateral stream habitats (e.g., sloughs, side channels, and pools) for refugia and food during their migration downstream and out to Puget Sound. Peak emigration occurs from March to July.

The amount of time juveniles spend in estuarine areas is dependent upon their size at downstream migration and rate of growth. Juveniles disperse to deeper marine areas when they reach approximately 65-75 mm in fork length (Simenstad *et al.* 1982). While residing in upper estuaries as fry, juvenile chinook have an affinity for benthic and epibenthic prey items such as amphipods, mysids, and cumaceans. As the juveniles grow and move to deeper waters with higher salinities, this preference changes to pelagic items such as decapod larvae, larval and juvenile fish, drift insects and euphausiids (Simenstad *et al.* 1982).

Chinook utilize the larger East Kitsap drainages, including Coulter, Rocky, Minter, Burley, Gorst, Chico and Dogfish Creeks (Williams *et al.* 1975). Carpenter Creek and most nearby streams are characterized by small drainages and low gradients, which are not typically used by chinook (Williams *et al*. 1975).

Beach seining conducted during mid-March to late July in 1991, 1992, and 1993 indicate that juvenile chinook salmon utilize nearshore intertidal areas at the Manchester Fuel Depot (Weitkamp 1994). In 1993, 140 chinook were captured by beach seine and 4 were captured by purse seine. This ratio indicates that during late spring and early summer, juvenile chinook utilize shallow (-2' to +2' MLLW) nearshore areas more than deeper (-55 to –60 feet MLLW) waters. Four of the chinook salmon caught was missing adipose fins, indicating the presence of coded wire tags. WDFW determined these fish came from the Clearwater Hatchery (Nisqually River) and the Green River Hatchery. During beach seines in 1993, 62 subyearling and 1 yearling chinook were captured on July 14$^{th}$, and 16 were captured on July 29$^{th}$.

The results of the beach seining appear to substantiate observations by others that during some years, juvenile chinook salmon from South Puget Sound river basins utilize East Kitsap County near shore areas for rearing habitat during the NMFS closure period for Puget Sound ESU chinook in marine waters, defined as March 1$^{st}$ through July 1$^{st}$.

## 2.9 Cultural Resources

Section 106 of the National Historic Preservation Act of 1966, as amended, requires that Federal agencies identify and assess the effects of Federally assisted undertakings on historic properties and to consult with others to find acceptable ways to resolve adverse effects. Properties protected under Section 106 are those that are listed on or eligible for listing on the National Register of Historic Places (NRHP). Eligible properties must generally be at least 50 years old, possess integrity of physical characteristics, and meet at least one of four criteria for significance. Regulations implementing Section 106 (36 CFR Part 800) encourage maximum coordination with the environmental review process required by the National Environmental Policy Act (NEPA) and with other statutes. The Washington State Archaeological Sites and Resources Act (RCW 27.53) and the Indian Graves and Records Act (RCW 27.44) may also apply.

A professional cultural resources reconnaissance survey is being conducted for the proposed project by a Corps archaeologist. Completed studies related to Section 106 compliance include an examination of the archaeological and historic site records electronic database of the Washington State Office of Archaeology and Historic Preservation (OAHP), background research, and an initial pedestrian survey of the project areas. The records search indicated that no properties listed on the National Register of Historic Places (NRHP) and no sites or structures listed on the state inventory are located within the proposed project area. The tidal level in the project area at the time of the initial survey was not sufficiently low enough to examine the lower intertidal areas and a follow up survey will be conducted during a minus tide to complete the field survey. The low tide survey will complete the identification of historic properties phase of the Section 106 process.

## 2.10 Socio-Economic Resources

Kitsap County has approximately 233,000 residents (Census website 2002), although the Kingston sub-area has a moderately low population density (295 persons per square mile) relative to the other county sub-areas density (Cutthroats, *et al.* 2001). The major employers in the county are the Naval station in Bremerton and its associated contractors, city and county school districts, hospitals, and a broad base of private businesses. A number of residents also commute to the Seattle area due to convenient ferry access. In the project vicinity, the land uses are rural to urban residential developments and quasi-public buildings such as churches and schools. The Carpenter Creek watershed is currently outside of the county's Urban Growth Area (UGA), but the lower half of the creek and estuary may get included in an expansion of the UGA (Cutthroats, *et al.* 2001).

Several parks are located in the Kingston area including Arness Roadside Park at the project site, Kingston Skate Park, Kingston Tennis Courts and Kola Kole Park.

According to the Kitsap County Geographic Information System (GIS) database, South Kingston Road is classified as a minor collector, and West Kingston Road is classified as a major collector. Both roads are undivided two-lane roadways. South Kingston Road provides a connection between Kingston and the residential developments and communities to the south, including the community of Indianola. West Kingston Road provides a connection between Hansville Road NE and the community of Kingston (See Figure 1).

Overhead phone lines, and underground storm and sewer lines are present along both roadways, and a water line and fiberoptic cable is present along West Kingston Road.

## 2.11 Hazardous and Toxic Wastes

A preliminary (Level 1) assessment of hazardous, toxic and radioactive wastes (HTRW) was conducted for the Carpenter Creek estuary project area. The complete text of the HTRW is provided in Appendix D. Results of the assessment indicated that the primary land uses in the watershed are residential, schools and churches, and forestland. No landfills are located within the watershed. Web site research indicated the presence of a Formerly Used Defense Site (FUDS) in the study area. The FUDS is former Nike Missile Site S-92, comprising a control site and a separate launch site. The launch site is reported to have been the site of a leaking underground storage tank (LUST). The site was remediated through tank removal and soil cleanup by the USACE.

Another site, located just outside of the watershed, is the former Viking Plating property, located approximately ½ mile east of the project area. This site likely has high levels of heavy metals such as arsenic, cadmium, chromium, lead and mercury, although it is the subject of remedial actions by the Washington Department of Ecology (DOE).
Based on the results of the HTRW assessment, it appears that all potential sources of hazardous or toxic materials in the project area are currently being remediated or are scheduled for remediation.

# 3. PLAN FORMULATION

## 3.1 Methodology

Plan formulation requires an analysis of potential alternative restoration measures (alternative measures) that would individually, or in combination, achieve the goals of the project. The project goals include restoration of natural tidal hydrologic fluctuations in the estuary, reclamation of some of the historic intertidal habitat and salt marsh habitat by removing fill material, removing fish passage barriers (high-velocity culvert openings and perched culvert inverts), elimination of sediment scour and depositional problems, and reduction of the fragmentation between the marine shoreline environments and the upstream estuarine environments.

The first step of the plan formulation was the conceptual development of specific alternative measures and their associated cost estimates. The alternative measures that were considered in the plan formulation process were previously identified in previous reports, including the *Final Preliminary Restoration Plan for Carpenter Creek Estuary* (USACE 2001a). The tools that were used to develop and evaluate the alternative measures included numerical hydraulic modeling, field assessments of existing hydraulic conditions and field assessments of existing habitat conditions.

After the alternative measures were identified and formulated, a habitat benefits analysis was conducted to quantify the habitat benefits associated with the implementation of each of the alternative measures. Output from the numerical hydraulic modeling combined with the field observations of the habitat conditions were the primary inputs into the habitat benefits analysis. The habitat benefits analysis is described in detail in Section 3.4.

The results of the habitat benefits analysis and the determination of the conceptual level costs estimates were then input into a cost effectiveness/incremental cost analysis (CEA/ICA) to determine the subset of alternative measures which best meet the project goals and which are the most cost effective. The CEA/ICA is described in detail in Section 3.5.

The plan formulation section of this report summarizes the previous work and analyses that were conducted during the plan formulation process. The *Carpenter Creek Estuary Section 206 Draft Fact Sheet* (Tetra Tech 2002) should be referenced for additional information on the plan formulation process, the alternative measures, the conceptual design plans of the alternative measures, and the conceptual cost estimate spreadsheets of the conceptual measures.

## 3.2 Project Criteria and Constraints

The main project objectives are: (1) to restore natural tidal hydrologic fluctuations in the estuary; (2) reclaim some of the historic intertidal habitat and salt marsh habitat by removing fill material; (3) remove fish passage barriers (high-velocity culvert openings and perched culverts); (4) eliminate localized scour problems and reduce depositional problems; and, (5) reduce the fragmentation of shoreline and upstream habitats and environments.

The proposed restoration measures would ultimately increase the estuary, shoreline, and habitat areas used by Puget Sound chinook salmon (listed as threatened under the Endangered Species Act), and a variety of other fish species, including coho, chum, sea-run cutthroat and steelhead trout. Additionally, restoration activities would restore the natural processes of tidal, sediment and detritus exchange essential for maintaining high quality estuarine habitats. Finally, restoration project goals align well with the regional restoration goals of reducing watershed/estuary/shoreline fragmentation, which has contributed to the decline of the Puget Sound chinook salmon population (WSCC 2000). The Carpenter Creek / Appletree Cove restoration project is a large estuary with quality habitat and at a crucial location for migrating salmonids and it plays a key role in regional restoration efforts for salmon in the Puget Sound.

To attain the project objectives, specific project criteria were identified and used in plan formulation to determine the recommended plan. The project criteria included general criteria and technical criteria, both of which are listed below:

General Criteria

- The recommended plan achieves the goals of the project and is sustainable over the long term (more than 50-years)
- Analyses of benefits and costs are to be conducted in accordance with Corps regulations, and the recommended plan is to be economically feasible in terms of current prices.

Technical Criteria

- Average velocities through any improved culvert/bridge opening must be less than 1 ft/s for 10% of the ebb portion of the tide cycle (Bottom, *et al*. 2001). To aide in the evaluation of different opening sizes and configurations, this velocity criterion is to be applied to an average tidal cycle, which was previously defined and described. Appendix C (Hydrology and Hydraulics) also contains a description of the derivation of the average tide cycle.
- The project should be designed to minimize the operation and maintenance (O&M) required of the local sponsor.
- The project must minimize the removal of existing trees and vegetation in and along the estuary.

In addition to the above stated criteria, there were several site-specific constraints that existed and that partially provided the framework for the development of the alternative measures, and ultimately, the recommended plan. These site-specific constraints include the following:

- Within the main estuary, between West Kingston Road and South Kingston Road, the estuary is entirely within private ownership, including the land area below MHW.
- Upstream of West Kingston Road, the land area below MHW is under ownership of the Kitsap County Parks Department, and a majority of the land that is beneath maximum tidal inundation is also under ownership of the County. However, ownership to the north, west, and east of this portion of the estuary is entirely private. The upper lobe of the estuary is currently only accessible from the West Kingston Road right of way.

- One lane of South Kingston Road must remain open for traffic throughout the construction of the improvements.
- West Kingston Road may be closed entirely to through traffic for improvements in and alongside West Kingston Road.
- Work closure periods for state and federally protected species may apply, and include Puget Sound Chinook and bull trout (marine), bald eagle and Pacific sand lance.
- The Section 206 program limits the federal share of any one project to $5,000,000.

## 3.3 Presentation of Alternative Measures

As a first step in the plan formulation for this restoration project, an array of alternative measures were developed that met the established objectives. The alternative measures were developed to a conceptual level of detail; sufficient for conducting a spreadsheet based cost estimate, for evaluating habitat benefits, and for conducting a CEA/ICA in support of determining a recommended alternative plan.

A hydraulic/hydrologic analysis was conducted to provide the basis of design for some of the alternative measures, namely the culvert improvement alternative measures, and to provide input into the habitat benefits analysis. The hydraulic/hydrologic analysis that was conducted during the plan formulation is described in detail in Appendix C of this feasibility report.

A preliminary geotechnical evaluation was conducted for the project (GeoEngineers 2002). The purpose of the geotechnical evaluation was to provide site surface and subsurface conditions and to provide preliminary recommendations for foundation support for the two proposed culvert improvements. The Preliminary Geotechnical Engineering Services Report (GeoEngineers 2002) is included in Appendix B of this feasibility report.

The nine alternative measures that were developed during plan formulation are described below. Refer to the *Carpenter Creek Estuary Section 206 Draft Fact Sheet* (Tetra Tech 2002) for figures showing the locations of each of the alternative measures.

<u>Measure 1: South Kingston Road Single Span Bridge</u>

This alternative measure proposes to replace the existing 10-foot by 10-foot reinforced concrete box (RCB) culvert at South Kingston Road (Figure 10) with a precast, prestressed single span bridge structure. The bottom width of the new channel through the opening of the bridge would be approximately 50 feet. Side slopes up to the abutments of the bridge opening would be approximately 3:1. The enlarged opening would be excavated through the existing road embankment at the site of the existing culvert and would provide improved conditions for fish passage and wildlife migration.

The proposed bridge structure would be a 70-foot single span, 35-foot wide concrete girder bridge and would be constructed within the current road right-of-way. The foundation for each bridge abutment would have twin concrete reinforced drilled caissons, drilled to a depth of approximately 60 feet below the roadway surface. Riprap bank protection would be placed within the cross section of the bridge opening to protect the integrity of the road embankment and the bridge foundation.

**Figure 10. Downstream Side of the South Kingston Road Culvert**

Measure 2: South Kingston Road Culvert

This alternative measure proposes to replace the existing 10-foot by 10-foot RCB culvert crossing at South Kingston Road with twin bottomless arch culverts. The proposed culverts would be twin 32-foot span precast, prestressed bottomless arch culverts. The length of each culvert would be approximately 40-feet. The twin culverts would be constructed along the alignment of the existing culvert and would provide improved conditions for fish passage into and out of the estuary.

The culverts would have head walls and wing walls at each end. Due to the highly liquefiable subsurface beach deposits that were encountered at the site (GeoEngineers 2002), it was recommended that a deep foundation system, similar to that recommended for the single span bridge alternative, be used to support the precast culverts and the overburden from the roadway fill. Twin concrete reinforced drilled caissons were recommended on the north side and south side of the culverts. A set of two concrete reinforced drilled caissons would be constructed as a common foundation between the two culverts. In total, three sets of caisson foundations are proposed, drilled to a depth approximately 60 feet below the roadway surface. Riprap bank protection would be placed and buried at the culvert foundation.

Measure 3: West Kingston Road Single Span Bridge

This alternative measure proposes to replace the existing 5-foot diameter reinforced concrete pipe (RCP) at West Kingston Road (Figure 11) with a precast, prestressed single span bridge structure. The bottom width of the channel through the opening of the bridge would be approximately 10 feet. Side slopes up to the abutments of the bridge opening would be approximately 3:1. The enlarged opening would be excavated through the existing road embankment at the site of the existing culvert and would provide improved conditions for fish passage into and out of the estuary, would provide improved conditions for sediment transport from the upper estuary into the main estuary, and would provide a previously unavailable wildlife corridor.

The proposed bridge structure would be a 50-foot single span, 42-foot wide concrete girder bridge and would be constructed in the current roadway alignment. The foundation for each bridge abutment would be comprised of concrete filled steel piles, placed to a depth of approximately 35 feet below the roadway surface. Riprap bank protection would be placed within the cross section of the bridge opening to protect the integrity of the road embankment and the bridge foundation.

**Figure 11. Downstream Side of the West Kingston Road Culvert**

Measure 4: West Kingston Road Culvert

This alternative measure proposes to replace the existing 5-foot diameter RCP crossing on West Kingston Road with a box culvert. The proposed channel would have a 20-foot bottom width through the culvert and would be excavated through the existing road embankment to provide adequate fish passage to and from the estuary. The proposed culvert would be a 20-foot span precast concrete box culvert. The length of the culvert would be approximately 55 feet. The culvert would be constructed along the alignment of the existing culvert and would provide improved conditions for fish passage into and out of the estuary and improved conditions for sediment transport from the upper estuary into the main estuary.

The proposed box culvert would have head walls and wing walls at each end. The bottom invert of the box culvert would be set approximately 2 feet below the channel invert to provide a mobile bed and natural substrate for habitat benefits. Glacial till at the West Kingston Road site was encountered approximately 15 feet below the road surface, and as such it was assumed that the box culvert could be supported on a shallow foundation that extended into the dense glacial till material. Over excavation would be required to remove the several feet of recent alluvium and peat that overlay the glacial till (GeoEngineers 2002). Riprap bank protection would be placed and buried at each end of the culvert.

Measure 5: Abandoned Roadbed Excavation

This alternative measure proposes the removal of the remnant embankments of an abandoned roadway, located approximately 200 feet upstream from West Kingston Road. Figure 12 shows a photograph taken during low tide, from West Kingston Road looking approximately north. The embankments of the abandoned roadbed can be seen across the center of the photograph. The remnant embankments would be graded and shaped to conform to the existing estuary contours. In addition, $3^{rd}$ and $4^{th}$ order tidal drainage channels would be dredged and plantings of native vegetation would occur within the excavated area, as appropriate. This alternative measure would result in the removal of approximately 152 cubic yards of fill material. The proposed excavation will be conducted in such a manner as to minimize adverse effects to existing high quality LWD and riparian cover in the vicinity. It is assumed that access to the site of the excavation will occur through the upland area adjacent to the estuary and will require easements through private property on both sides of the estuary.

**Figure 12. Abandoned Road Bed**

Measure 6: Sediment Deposit Excavation/Dredging and Tidal Drainage Network Excavation/Creation North of West Kingston Road

This alternative measure proposes to remove sediment deposits in two locations, one immediately upstream of West Kingston Road and the other immediately upstream from the abandoned roadway that is proposed for removal as part of Alternative Measure 5. The proposed excavation would also incorporate grading of new tidal drainage network channels in the same area. Alternative 6 would result in approximately 2,500 cubic yards of excavation of fine sediment within the mudflats of the estuary.

Measure 7: Fill Scour Holes and Reconfigure Tidal Drainage Channel Adjacent to South Kingston Road Culvert

This alternative measure proposes to fill the existing scour holes that have developed on both the upstream and the downstream sides of the existing South Kingston Road box culvert. It is assumed that largely imported material will be used to fill the scour holes; if appropriate, some on-site material from the road embankments could be used to fill the bottom of the scour holes.

This alternative measure also proposes to regrade the tidal drainage channel upstream of the upstream scour hole. It is proposed to regrade the channel to provide a transitional gradient between the scour hole and the upstream channel to minimize headcutting of the tidal channel. Alternative measure 7 would result in approximately 500 cubic yards of tidal drainage excavation and 600 cubic yards of fill, utilizing primarily imported materials.

Measure 8: Riparian Vegetation Plantings

This alternative measure would provide approximately one acre of riparian plantings and 0.25 acres of riparian underplantings. The areas of riparian planting include: 50-foot by 50-foot areas on each end and on the upstream and downstream sides of the West Kingston culvert replacement, a 50-foot by 400-foot area on the west side of the culvert replacement on South Kingston Road, and disturbed areas upstream of West Kingston Road. The area of riparian underplantings also includes a 0.25-acre area along the edge of the estuary southwest of West Kingston Road that is currently dominated by non-native species. In this area, non-native species would be removed first, and then native species would be planted. Additionally, native plantings would be incorporated into the abandoned roadbed excavation (Measure 5) and sediment / tidal drainage channel excavations (Measure 6), as appropriate, and might include high salt marsh or riparian species.

Measure 9: Additional Habitat Features

This alternative measure proposes to place approximately 100 pieces of large woody debris (LWD) at specific locations within the mudflats and marsh areas of the Carpenter Creek estuary. The 100 pieces of LWD would be grouped into approximately 13-15 LWD structures. Woody material is naturally occurring within estuarine environments, and is typically found along the fringes of the mud flat habitat. Woody material contributes to channel form, and provides cover, nesting, perching and foraging habitat for fish and wildlife species. The 13-15 LWD structures would be primarily placed along the fringes of the mudflat environment; however, it is also proposed to place several of them within the tidal channel area to provide for aquatic habitat. The LWD would be anchored into the substrate of the estuary with duckbill anchors, or their equivalent.

Planning level (10%) project cost estimates were developed for each alternative measure, and included, construction costs, planning engineering and design (PED) costs, first year operation and maintenance (O&M) costs, and real estate costs. Real estate costs were provided by the Seattle District USACE in the form of unimproved, per-acre, assessed land values for each privately owned parcel with the alternative measure footprint. The real estate costs associated with each measure were calculated by multiplying the footprint of each measure by the per-acre land value of every parcel located within the footprint.

The planning level cost estimates were used as input into the cost effectiveness and incremental cost analysis to compare the relative cost per habitat unit of output. Table 2 shows the planning level cost estimates that were developed during plan formulation for each of the alternative measures.

**Table 2. Planning Level Cost Estimates for Alternative Measures**

| Alternative Measure | Planning Level Cost Estimate |
|---|---|
| 1. South Kingston Road Bridge | $1,815,568 |
| 2. South Kingston Road Culvert | $2,212,665 |
| 3. West Kingston Road Bridge | $754,892 |
| 4. West Kingston Road Culvert | $710,704 |
| 5. Abandoned Roadbed Excavation | $42,122 |
| 6. Sediment Excavation/Dredging | $169,559 |
| 7. Fill in Scour Holes at South Kingston Road | $48,496 |
| 8. Estuary/Riparian Vegetation Plantings | $72,119 |
| 9. Additional Habitat Features - LWD | $154,413 |

## 3.4 Habitat Benefits Analysis

Habitat benefits (outputs) were quantified for this project using a qualitative description of the various physical parameters required for high quality juvenile salmon habitat in estuaries in conjunction with a weighting scheme for the various habitat types present in the estuary. Habitat benefits (outputs) were quantified for the future without project condition and for the condition that would result from the implementation of each one of the individual alternative measures. This methodology was based on work by Beamer, *et al.* (2001) and Dean, *et al*. (undated) for the Skagit River estuary.

The future without project condition was assumed to be approximately the same as the existing condition. The current culverts have been in place for nearly 50 years, and the hydraulic conditions resulting from the undersized culverts should not change significantly in the future. The current distribution of habitat types present in the estuary is the result of a gradual shift to a new equilibrium, and the scale of expected change in habitat types in the future is anticipated to be slow enough that the existing condition is felt to reasonably represent the future without project condition.

As will be described in more detail in Section 3.5 (Cost Effectiveness/Incremental Analysis), the implementation of the West Kingston culvert alternative measures (Alternative Measures 3 and 4) was assumed dependent on the implementation of one of the South Kingston alternative measures (Alternative Measures 1 and 2). Therefore, the cost effectiveness/incremental analysis (CEA/ICA) required the addition of four alternative measures (10a, 10b, 10c, and 10d). These four additional alternative measures capture the four possible combinations of new bridge or new culvert at each of the two road crossings, and are summarized in the matrix presented as Table 3.

**Table 3. Additional Alternative Measures**

| **Additional Alternative Measure ID** | **West Kingston Road** | | **South Kingston Road** | |
|---|---|---|---|---|
| | New Culvert | New Bridge | New Culvert | New Bridge |
| 10a | | X | | X |
| 10b | | X | X | |
| 10c | X | | | X |
| 10d | X | | X | |

The physical parameters that were used as input into the habitat benefits analysis included: 1) hydrology/sediment transport; 2) riparian buffers; 3) fish passage/accessibility; and 4) localized salmon rearing habitat and presence of LWD. Scores for each physical parameter ranged from zero to one, with a score of one representing very high quality habitat and a score of zero representing poor habitat. Table 4 summarizes each of the physical parameters, and the relative scoring system that was used to evaluate habitat conditions. For the future without project condition, and for the condition that would result from the separate implementation of each of the alternative restoration measures, a score was assigned for each of the physical parameters. The scores were then summed to provide an overall quality score. The maximum quality score for the future without project condition or for the condition following implementation of a given alternative measure was 4 points.

**Table 4. Physical Parameter Scoring Criteria Definitions**

| Score | Description |
|---|---|
| | ***Hydrology/Sediment Transport*** |
| 1 | Natural (or uncontrolled) tidal exchange and upstream freshwater inflow occurs within the channels and wetlands in the majority of the evaluation area. Channel formation and migration is unconstrained and LWD and sediment transport occur naturally for the geomorphic setting. |
| | Tidal exchange and/or freshwater inflow are constrained via culverts, levees or other structures in the majority of the evaluation area. Channel formation and migration is constrained by levees, etc. and LWD and sediment transport are reduced by constrictions or increased by unnaturally high flow velocities |
| 0 | No hydraulic connections exist between rivers, streams, estuaries, or bays in the evaluation area, except during flood flows or extreme high tides. No noticeable channel formation or migration is occurring and tidal channels may be filling in with sediment |
| | ***Riparian Buffers*** |
| 1 | Riparian zone or other appropriate native buffer averages 100 feet or more on both banks of channels, wetlands, or estuaries throughout the evaluation area and is dominated by native species |
| | Riparian zone or other appropriate native buffer averages 25-50 feet on either bank throughout the evaluation area, and/or non-native species are dominant |
| 0 | Riparian zone or other appropriate native buffer averages less than 25 ft throughout the evaluation area and/or is dominated by non-native species in most areas |
| | ***Fish Passage/Accessibility*** |
| 1 | Aquatic habitats within the evaluation area are fully accessible to both adult and juvenile fish as expected for the geomorphic and hydrologic (tidal) setting. Velocities are below 1.0 ft/sec throughout the majority of the tidal cycles (more than 90% of the time) to allow unlimited juvenile salmon access |
| | Aquatic habitats are infrequently accessible to fish, due to high velocities, low flows, etc. (more than 30% of the time) |
| 0 | Aquatic habitats within the evaluation area are not accessible to fish, except during slack tides |
| | ***Salmon Rearing Habitat/LWD*** |
| 1 | Habitat types within the evaluation area are highly diverse and of high quality. LWD is abundant for geomorphic setting |
| | Habitat types are reduced in number or size compared to what would be expected of the geomorphic setting and/or are moderately degraded. LWD is reduced |
| 0 | Habitat types are not representative of what would be expected of the geomorphic setting and/or are highly degraded. LWD is absent |

The area of each type of habitat present in the estuary was also calculated, with the assumption that habitat area is proportional to the volume of the tidal prism. The calculations were based on the proportion of tidal prism to the area of each habitat type present in the existing estuary. For the improved condition, the areas associated with each habitat type were adjusted based upon the predicted increase in volume of the tidal prism. The proportion was calculated as shown in Equation 1.

$$\left[\frac{TP_{ex}}{H_{ex}}\right] = \left[\frac{TP_{prop}}{H_{prop}}\right] \qquad \text{(Equation 1)}$$

Where,

$TP_{ex}$ = Tidal Prism Volume for Existing Conditions (acre-feet)

$H_{ex}$ = Area of Specific Habitat Type for Existing Conditions (acres)

$TP_{prop}$ = Tidal Prism Volume for Proposed Conditions (acre-feet)

$H_{prop}$ = Area of Specific Habitat Type for Proposed Conditions (acres)

The various types of habitat were then weighted based on guidance presented in Beamer *et al.* (2001) and Dean *et al.* (undated). Estuarine areas are very important for juvenile salmonid rearing, particularly chinook and chum salmon. All parts of the estuary are utilized by juvenile salmonids, however, the various habitat types are weighted differently because tidal channels provide the most significant rearing opportunities and are considered the most important to restore and maintain for juvenile rearing. Tidal mudflats provide a secondary level of functioning, and estuarine and freshwater marsh habitats are weighted the lowest. This ranking is partially based on the frequency of tidal inundation (i.e. the percent of time they can be used) and the types of prey resources found within each of the habitats. Although all habitat types present in estuaries provide important habitats for various fish and wildlife species, the weighting factors shown in Table 5 are based on the value of the habitat types for juvenile salmon rearing.

Table 6 summarizes the individual habitat acreages and the total weighted acreage for the future without project condition and for each of the alternative measures.

**Table 5. Weighting Factors for Habitat Types**

| Major Habitat Type | Weighting Factor |
|---|---|
| Estuarine Tidal Channels | 3 |
| Mudflat | 2 |
| Estuarine Wetland (marsh or scrub/shrub) | 1 |
| Freshwater Channel | 1 |
| Freshwater Wetlands | 1 |

**Table 6. Total Weighted Habitat Acreages for Each Alternative Measure**

| Alternative Measure | Habitat Type and Acreage of Habitat Type | | | | | Total Weighted Acreage |
|---|---|---|---|---|---|---|
| | Tidal Channel (3) | Mudflat (2) | Salt Marsh (1) | Freshwater Wetland (1) | Freshwater Channel (1) | |
| **Future Without Project** | **1.51** | **14.11** | **5.84** | **0.78** | **0.04** | **39.41** |
| 1 | 1.85 | 13.87 | 5.74 | 0.78 | 0.04 | 39.85 |
| 2 | 1.85 | 13.87 | 5.74 | 0.78 | 0.04 | 39.85 |
| 3 | 1.52 | 14.11 | 5.84 | 0.77 | 0.04 | 39.43 |
| 4 | 1.52 | 14.11 | 5.84 | 0.77 | 0.04 | 39.43 |
| 5 | 1.51 | 14.16 | 5.89 | 0.78 | 0.04 | 39.62 |
| 6 | 1.81 | 13.81 | 5.84 | 0.78 | 0.04 | 39.71 |
| 7 | 1.51 | 14.11 | 5.84 | 0.78 | 0.04 | 39.41 |
| 8 | 1.51 | 14.11 | 5.84 | 0.78 | 0.04 | 39.41 |
| 9 | 1.51 | 14.11 | 5.84 | 0.78 | 0.04 | 39.41 |
| 10a | 1.89 | 14.11 | 5.84 | 0.39 | 0.04 | 40.50 |
| 10b | 1.89 | 14.11 | 5.84 | 0.39 | 0.04 | 40.50 |
| 10c | 1.89 | 14.11 | 5.84 | 0.39 | 0.04 | 40.50 |
| 10d | 1.89 | 14.11 | 5.84 | 0.39 | 0.04 | 40.50 |

The total weighted habitat area was then multiplied by the quality score to yield the number of habitat units. For example, a site with an overall quality score of 2.5 points and 1.0 acres of estuarine tidal channels and 5 acres of estuarine wetland yields the following number of habitat units:

(1 acre estuarine channel * 3) + (5 acres estuarine wetland * 1) = 8 weighted acres

and, (8 weighted acres) * (quality score of 2.5) = 20 habitat units (HUs)

The acreage used for the future without project condition is equal to the existing acreage for each habitat type, as shown in Figure 13. The acreage used for each of the alternative measures were estimated based on the expected change in habitat resulting from implementation of each type of measure. For example, restoring natural hydrologic fluctuations by replacing the existing box culvert at South Kingston Road with a single span bridge would likely change habitat types within the main lobe of the estuary (between South Kingston Road and West Kingston Road).

Some existing mudflat habitat would likely change into estuarine tidal channel habitat due to the increased volume of inflow during tidal cycles and increased sediment transport out of the estuary. For this example, the increase in tidal channel habitat was assumed to be directly proportional to the increase in tidal inflow volume resulting from the increased size of the opening.

Table 7 presents the results of the habitat benefits analysis. The table summarizes the physical parameter scores, the overall quality scores, the total weighted habitat acres and the habitat units for the future without project condition and the anticipated conditions resulting from the implementation of each of the alternative restoration measures. As will be discussed in the CEA/ICA section of this report, the culvert improvement at West Kingston Road (Alternative Measures 3 and 4) was assumed to be dependent on the culvert improvement at South Kingston Road. Therefore, scoring and habitat output were not determined for Alternative Measures 3 and 4, and four additional alternative measures were created (10a, 10b, 10c, and 10d).

**Table 7. Habitat Outputs for Each Alternative Measure**

| Alternative Measure | Hydrology | Riparian | Fish Passage | LWD | Overall Quality Score | Total Weighted Acreage | Habitat Units (HU) | Change |
|---|---|---|---|---|---|---|---|---|
| Future Without Project | 0.50 | 0.50 | 0.0 | 0.40 | 1.4 | 39.41 | 55.17 | *0* |
| 1. South Kingston Bridge | 0.75 | 0.50 | 0.50 | 0.40 | 2.15 | 39.85 | 85.68 | *30.50* |
| 2. South Kingston Culvert | 0.70 | 0.50 | 0.50 | 0.40 | 2.10 | 39.85 | 83.69 | *28.51* |
| 3. West Kingston Bridge | *Dependent on Implementation of South Kingston Culvert Improvement (see combinations below (10.a-10.d)* | | | | | | | |
| 4. West Kingston Culvert | *Dependent on Implementation of South Kingston Culvert Improvement (see combinations below (10.a-10.d)* | | | | | | | |
| 5. Abandoned Roadbed Excavation | 0.55 | 0.50 | 0.0 | 0.4 | 1.45 | 39.62 | 57.45 | *2.28* |
| 6. Sediment Excavation/ Dredging (North of W. Kingston Rd.) | 0.60 | 0.50 | 0.10 | 0.4 | 1.6 | 39.71 | 63.54 | *8.36* |
| 7. Fill in Scour Holes (@ S. Kingston Rd.) | 0.50 | 0.50 | 0.10 | 0.4 | 1.5 | 39.41 | 59.12 | *3.94* |
| 8. Estuary/Riparian Vegetation Plantings | 0.50 | 1.0 | 0.0 | 0.5 | 2.0 | 39.41 | 78.82 | *23.65* |
| 9. Additional Habitat Features (Large Woody Debris) | 0.50 | 0.50 | 0.0 | 1.0 | 2.0 | 39.41 | 78.82 | *23.65* |
| 10.a. W. Kingston Rd. Bridge with S. Kingston Rd. Bridge | 1.0 | 0.50 | 1.0 | 0.4 | 2.9 | 40.5 | 117.45 | *63.09* |
| 10.b. W. Kingston Rd. Bridge with S. Kingston Rd. Culvert | 0.90 | 0.50 | 1.0 | 0.4 | 2.8 | 40.5 | 113.40 | *59.04* |
| 10.c. W. Kingston Rd. Culvert with S. Kingston Rd. Bridge | 0.95 | 0.50 | 1.0 | 0.40 | 2.85 | 40.5 | 115.43 | *61.06* |
| 10.d. W. Kingston Rd. Culvert with S. Kingston Rd. Culvert | 0.85 | 0.50 | 1.0 | 0.4 | 2.75 | 40.5 | 111.38 | *57.01* |

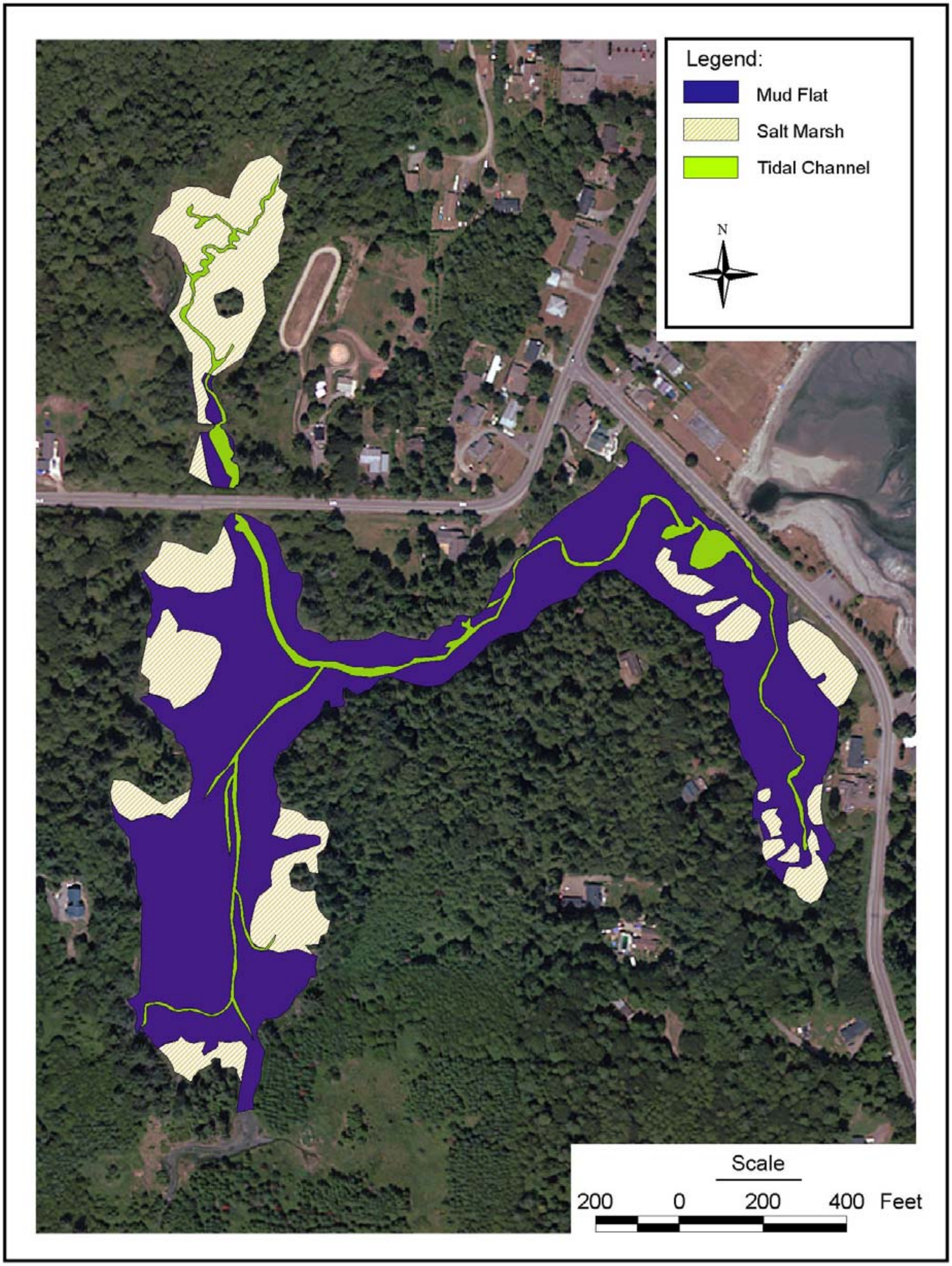


**Figure 13. Existing Habitat Types**

### 3.5 Cost Effectiveness/Incremental Cost Analysis

Relationships between the nine alternative measures outlined in Section 3.3 were identified. Certain alternative measures were determined to be dependent on the construction of other alternative measures, and certain alternative measures were assumed not combinable with other alternative measures. For instance, the implementation of the culvert improvement at West Kingston Road was assumed dependent on the implementation of the culvert improvement at South Kingston Road. This was assumed because the South Kingston Road culvert is the primary hydraulic restriction in terms of tidal prism, and therefore, there are limited hydrologic benefits associated with only improving the West Kingston Road culvert. Therefore, for the purposes of the CEAICA, this dependency relationship required the creation of another set of alternative measures (Alternative Measures 10a, 10b, 10c, and 10d) to replace Alternative Measures 3 and 4.

The alternative measures that were not combinable with other alternative measures, and the alternative measures that were dependent on the construction of other alternative measures are shown in Table 8.

The planning level (10%) project cost estimates that were developed for each alternative measure are also shown in Table 8. These costs included, construction costs, planning engineering and design (PED) costs, operation and maintenance (O&M) costs, and real estate costs.

An alternative matrix was then developed to organize the input data for the Corps IWR-PLAN software that was used to formulate all possible combinations of the measures and to perform cost effectiveness and incremental cost analysis. The matrix is shown below in Table 8.

**Table 8. Alternative Measures with Cost, Output and Relationships**

| Alternative Measure | Code | Scale | Alternative Measure Description | Total Planning Level Cost (Present Value*) | Average Annual Cost* | Total Output | Average Annual Output** | Not Combinable With: | Dependent On: |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 1 | South Kingston Road Bridge | $1,815,568 | $113,183 | 30.50 | 0.61 | G | D |
| 2 | A | 2 | South Kingston Road Culvert | $2,212,665 | $137,938 | 28.51 | 0.57 | G | D |
| 5 | B | 1 | Abandoned Road Bed Excavation | $42,122 | $2,626 | 2.28 | 0.05 | | A or G |
| 6 | C | 1 | Sediment Excavation/Dredging North of West Kingston Road | $169,559 | $10,570 | 8.36 | 0.17 | | G |
| 7 | D | 1 | Fill Scour Holes at South Kingston Road | $48,496 | $3,023 | 3.94 | 0.08 | | |
| 8 | E | 1 | Estuarine/Riparian Plantings | $72,119 | $4,496 | 23.65 | 0.47 | | A or G |
| 9 | F | 1 | Additional Habitat Features (Large Woody Debris) | $154,413 | $9,626 | 23.65 | 0.47 | | A or G |
| 10a | G | 1 | West Kingston Road Bridge + South Kingston Road Bridge | $2,570,460 | $160,243 | 63.09 | 1.26 | A | D |
| 10b | G | 2 | West Kingston Road Bridge + South Kingston Road Culvert | $2,967,557 | $184,998 | 59.04 | 1.18 | A | D |
| 10c | G | 3 | West Kingston Road Culvert + South Kingston Road Bridge | $2,526,272 | $157,488 | 61.06 | 1.22 | A | D |
| 10d | G | 4 | West Kingston Road Culvert + South Kingston Road Culvert | $2,923,369 | $182,243 | 57.01 | 1.14 | A | D |
| * | *Based upon FY03 Federal Discount rate of 5.875% and 50 year period of analysis* | | | | | | | | |
| ** | *Based upon 50 year period of anlaysis* | | | | | | | | |

Using IWR-PLAN, a total of 82 possible alternative combinations of the measures in Table 8 were formulated and analyzed. A cost effectiveness analysis was conducted to identify those of the set of 82 alternatives that are cost-effective. Cost effective combinations are defined in this case as those alternatives that provide more output than others at the same or less cost, or those alternatives that provide that same output for less cost than other alternatives. Of the 82 possible alternative combinations, 17 were found to be cost effective. The cost effective plans are included in Figure 14.

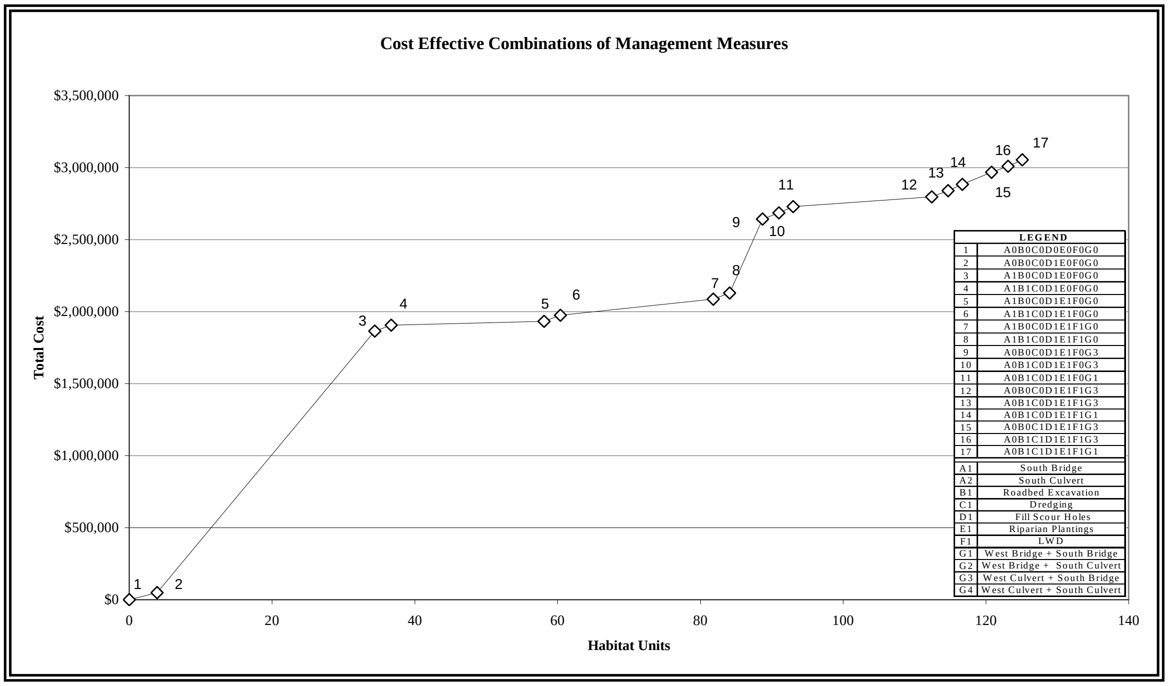


**Figure 14. Cost Effectiveness Analysis Graph**

An incremental cost analysis was conducted for the seventeen cost effective combinations to identify the most efficient production options for providing environmental outputs; these combinations are called best buys. Of the seventeen cost effective combinations, three were identified as best buys. Table 9 and Figure 15 present the results of the incremental cost analysis.

**Table 9. Incremental Cost Analysis Data**

| | Combination Code | Total Cost ($) | Incremental Cost ($) | Total Output (HUs) | Incremental Output (HUs) | Incremental Cost Per Output ($) |
|---|---|---|---|---|---|---|
| 1 | A0B0C0D0E0F0G0 | $0 | $0 | 0 | 0 | $0 |
| 2 | A0B0C0D1E0F0G0 | $48,496 | $48,496 | 3.9 | 3.9 | $12,435 |
| 3 | A0B1C1D1E1F1G1 | $3,053,401 | 3004905 | 124.8 | 120.9 | $24,489 |

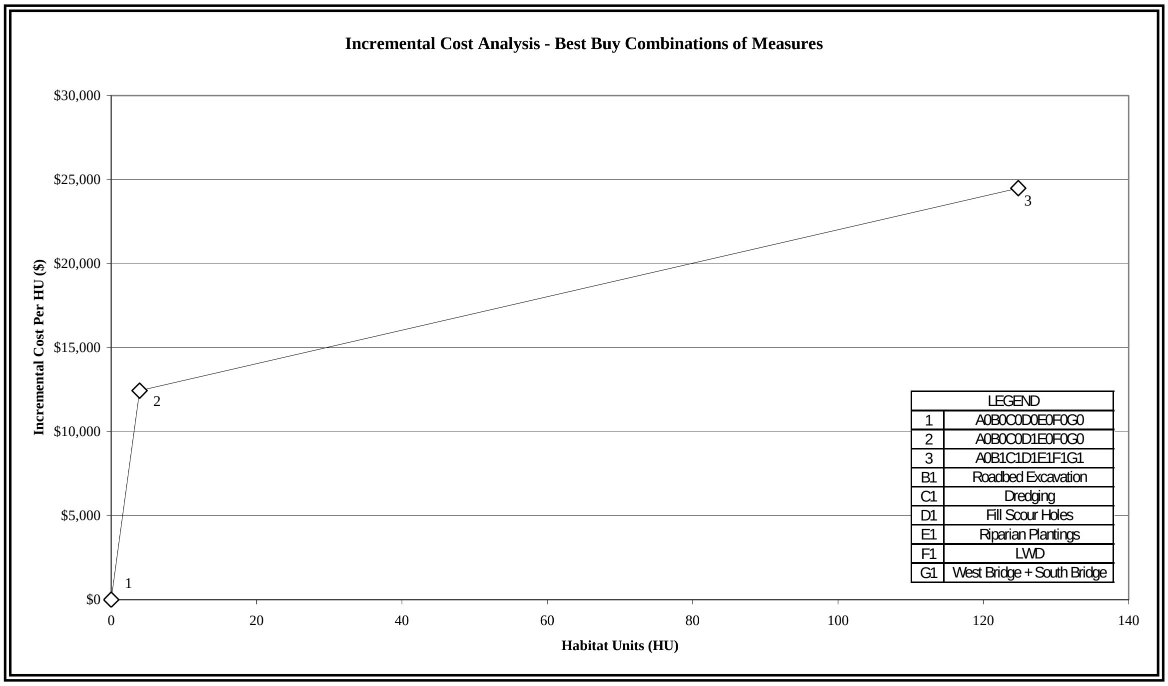


**Figure 15. Incremental Cost Analysis Graph**

## 3.6 Selection and Justification of Preferred Alternative Plan

Combination 3, as presented in Table 9 and Figure 15 is selected as the preferred alternative plan. This combination of alternative measures includes the following: construction of the South Kingston Road Bridge, construction of the West Kingston Road Bridge, removal of the abandoned roadbed, sediment excavation/dredging upstream of West Kingston Road, filling of the scour holes at South Kingston Road, riparian plantings, and placement of large woody debris.

Combination 2 is the most efficient plan at producing output but does not provide a significant level of environmental outputs by itself. The features of Combination 2 are included in Combination 3, which provides a significantly higher level of environmental output.

The selected alternative will provide significant benefits to both fish and wildlife species, particularly salmonid species. It would restore natural hydrologic function to the Carpenter Creek / Appletree Cove estuary and provide full fish passage to over 30 acres of high quality estuarine habitat. Estuarine habitat would further be enhanced by riparian plantings that will buffer the estuary from the roadways. Placement of LWD in the mudflats, tidal channels and salt marsh areas will provide important cover and rearing areas for juvenile salmon, and perching habitat and cover for a variety of wildlife species.

Chinook and chum salmon utilize estuarine habitats extensively, and the loss of those habitats within Puget Sound has been a major factor of decline for those species. Other salmon species also utilize estuarine habitats, although to a lesser extent. Estuarine habitat is very important as salmon species transition from the riverine freshwater environment and the saltwater environment. The loss of this habitat and the change in hydrologic regimes can cause direct mortality to juvenile salmon and can also adversely affect production due to the loss of rearing and feeding areas. Estuaries are also extremely important for a number of other wildlife species and would provide important nesting and feeding habitats for numerous migratory bird species including waterfowl. Restoration of estuarine habitats addresses these limiting factors.

### 3.7 Estimated Cost of Preferred Alternative Plan

The total estimated project cost for the preferred alternative plan, as determined in the plan formulation phase, is approximately $3,999,900. As described earlier, the total estimated project cost for this plan includes construction costs, planning engineering and design (PED) costs, supervisory and administration (S&A) costs, real estate costs, and first year operation and maintenance costs. The total construction cost for each alternative measure includes a 25% construction contingency. Planning, engineering and design costs (PED) were assumed to be 15% of the construction cost. Supervision and Administration costs (S&A) were assumed to be 12% of the construction cost. Real estate costs are also included in the cost estimates. Unit costs and material quantities for each of the nine alternative measures are documented in the *Carpenter Creek Estuary Section 206 – Draft Fact Sheet* (Tetra Tech 2002).

Preliminary operation and maintenance to establish the riparian plantings for Alternative Measure 8 were estimated as a one-year non-federal cost of $3,750. Following a flood event or extreme tidal/wave action, some minor erosion control efforts may be required to maintain channel stability. The bridge structures will also likely require periodic debris removal and regular maintenance inspections. Annual operation and maintenance costs were defined and were cost estimated to a greater level of detail during the feasibility phase, and are documented in Section 4.5 of this report.

# 4. RECOMMENDED PLAN

## 4.1 Description and Rational for Selection of Recommended Plan

The recommended plan, which stemmed from the plan formulation phase, is combination 3 (as identified in Table 9). This recommended plan includes the following alternative measures:

- Replacement of the concrete box culvert at South Kingston Road with a precast single span bridge (Alternative Measure 1).
- Replacement of the concrete circular culvert at West Kingston Road with a precast single span bridge (Alternative Measure 3).
- Excavation of the abandoned roadbed abutments, located approximately 200 feet upstream of West Kingston Road (Alternative Measure 5).
- Sediment excavation/dredging upstream of West Kingston Road (Alternative Measure 6).
- Fill the scour holes and reconfigure the tidal channel adjacent to South Kingston Road culvert (Alternative Measure 7)
- Riparian vegetation plantings (Alternative Measure 8)
- Additional habitat features – placement of large woody debris (Alternative Measure 9)

## 4.2 Modifications to Recommended Plan

As the recommended plan evolved from the 10% plan formulation phase to the 35% feasibility level phase, several of the alternative measures were modified, and some of the alternative measures were eliminated from further consideration. In general, the modifications to the recommended plan were driven by design comments submitted by the review team, which is comprised of representative staff from Kitsap County, the Corps, the Kitsap Conservation District and WDFW. In some cases the modifications were driven by design decisions that were made as site-specific details were investigated further. The modifications to each of the alternative measures are documented below. The Design/Cost Appendix (Appendix E) and the Hydrology and Hydraulics Appendix (Appendix C) include more detailed discussion of some the design modifications and the rational/analysis that supported them.

<u>Modified Measure 1 – South Kingston Road Bridge</u>

- The low chord elevation of the proposed South Kingston Road bridge was increased by approximately one foot to provide a minimum of one foot of vertical clearance between the historic high tide elevation and the proposed low chord of the bridge structure. At the mouth of the estuary, the historic high tide elevation was determined to be 12.0 feet (NAVD88). Refer to the Hydrology/Hydraulics Appendix (Appendix C) for the basis of this determination. Increasing the proposed low chord elevation of the bridge required that approximately 150 linear feet of South Kingston Road, on each side of the bridge abutments, also had to be raised.
- Raising the roadway profile by one foot necessitated the need to reconstruct the roadway embankments on the estuary side (west side) of South Kingston Road. The existing embankments are presently steeper than 2H:1V, and are currently being undercut in some locations. Therefore, approximately 300 linear feet of reconstructed roadway

embankments were required. The side slopes of the new embankments were designed at a slope of 2H:1V. Buried riprap toe protection combined with vegetated soil lifts and roadway slope plantings were used to provide slope stability.

- The span length of the bridge was increased from 70 feet to 95 feet. This modification was incorporated to minimize the length of the wingwalls that were required at each of the bridge abutments.
- A bank stability analysis was used to determine the critical grain size of the material necessary to armor the channel side slopes through the bridge opening. The analysis confirmed that the riprap material that was proposed during plan formulation was indeed conservative, and that the critical grain size diameter is approximately 0.25 inches. The analysis is documented in more detail in Section 3.3 of Appendix C. The actual gradation of the bank material will be determined during future design phases, however, it is anticipated that a uniformly graded material will be used below the MHW elevation and a well-graded material will be used above the MHW elevation. The inclusion of fines above the MHW elevation will allow for the establishment of future plantings. The proposed design of the South Kingston Road bridge opening is shown on Plate C5 of the design drawings.
- The geometry of the bridge opening was slightly modified to provide a low flow channel to up to the elevation of the mean tide. The side slopes of this low flow channel are proposed to be 6H:1V. To accommodate this low flow channel, the bottom width of the bridge opening was reduced from 50 feet to approximately 38 feet. The hydraulic model was refined to correspond with the new bridge opening geometry, and it was verified that the new opening still met the hydraulic design criteria. Refer to Appendix C for a detailed discussion and the results of this additional analysis.

<u>Modified Measure 3 – West Kingston Road Bridge</u>

- A bank stability analysis was used to determine the critical grain size of the material necessary to armor the channel side slopes through the bridge opening. The analysis confirmed that the riprap material that was proposed during plan formulation was indeed conservative, and that the critical grain size diameter is 1.8” below the 100-year water surface elevation and 0.05” above the 100-year water surface elevation. The analysis is documented in more detail in Section 3.3 of Appendix C. The actual gradation of the bank material will be determined during future design phases, however, it is anticipated that a uniformly graded material will be used below the MHW elevation and a well-graded material will be used above the MHW elevation. The inclusion of fines above the MHW elevation will allow for the establishment of future plantings. The proposed design of the South Kingston Road bridge opening is shown on Plate C7 of the design drawings.
- The geometry of the bridge opening was slightly modified to provide a channel to contain the 100-year flood event. The side slopes of this low flow channel are proposed to be 3.5H:1V. The hydraulic model was refined to correspond with the new bridge opening geometry and it was verified that the new opening still met the design criteria. Refer to Appendix C for a detailed discussion and the results of this additional analysis.

Modified Measure 5 – Abandoned Roadbed Excavation

- The review team expressed concerns regarding the extent of the proposed excavation. The team recommended that the excavation not be too aggressive because the existing roadbed, and the vegetation along the roadbed, does currently provide cover for wildlife.
- In discussions with the private property owner who owns the parcel located immediately west of the proposed roadbed excavation (Michael Kaestner – Parcel # 2627023025), the owner expressed interest in selling a portion of his property. This property acquisition would be valuable to the project in two ways. It would provide for overland access to the site of the proposed roadbed excavation and it would provide the County with a larger publicly owned buffer adjacent to the estuary. Therefore, County acquisition of the eastern-most 65-feet of the Kaestner property was included as part of this alternative measure. Refer to Plate R2 of the real estate drawings (Appendix F) for a depiction of the parcel boundaries in the vicinity of the Kaestner property.
- Access to the proposed roadbed excavation from the east side was determined to be unfeasible. Therefore, the extent of the abandoned roadbed excavation was limited to that which could be accessed from the west side only.

Modified Measure 6 – Sediment Excavation/Dredging Upstream of West Kingston Road

- Concerns were expressed by the review team regarding construction impacts on adjacent habitat and the removal of existing salt marsh that would result from the excavation associated with Alternative Measure 6. It was instead decided to allow the fine sediments that have deposited upstream of West Kingston Road to be naturally mobilized and transported downstream. The monitoring plan that was developed for the recommended plan includes tasks that will monitor the change in elevation of the mudflats upstream of West Kingston Road. Actions can be taken in the future if it is found that the sediment in the area has not mobilized on its own. ***Therefore, Alternative Measure 6 was eliminated from the recommended plan and was not considered further.***

Modified Measure 7 – Fill Scour Holes and Reconfigure Tidal Drainage Channel Adjacent to South Kingston Road Culvert

- Filling of the scour holes was favorable to the review team. However, WDFW indicated that they would prefer that the holes not be filled with cobble-sized material, such as quarry spalls. Therefore, the existing scour holes will be filled with imported material, up to an elevation approximately five feet below the top of the scour hole. It is anticipated that coarse sand or very fine gravels would be used, which have sufficient high clear water settling velocities that will allow for placement of the material between tide cycles. The remaining upper five feet of each scour hole will be filled using imported materials of similar grain size to the adjacent native materials.
- The conceptual level design for this alternative measure also proposed to excavate approximately 250 linear feet of transitional tidal channel to tie the invert elevation of the bridge opening to the elevation of the upstream tidal channel. There were concerns expressed about excavating within the tidal mudflats upstream of South Kingston Road, and the review team felt that it would be better to allow the profile of the tidal channel to

adjust naturally over time. ***Therefore, this component of the alternative measure was eliminated from the recommended plan and was not considered further.***

Modified Measure 8 – Riparian Vegetation Plantings

- The locations and the footprints of the plantings were modified based on comments from the review team.
- The proposed plantings were further subdivided into the following subgroups: riparian plantings, saltmarsh plantings and roadway embankment plantings. Where plantings were proposed, species suitable for salt marsh conditions were proposed in the zone one foot above MHW. Riparian plantings were proposed at elevations greater than 1 foot above MHW.

Modified Measure 9 – Additional Habitat Features - Placement of LWD

- Subsequent to the submittal of the draft 35% design and feasibility report, Alternative Measure 9 was eliminated from the recommended plan. There were two primary reasons for this change. First off, there was concern from both the County and the Corps regarding liability in the event that the LWD pieces were relocated through tidal action or flood flows to privately owned property, specifically privately owned property where easements had not been previously secured. Secondly, due to the large amount of the estuary that is privately owned, negotiations for temporary and possibly long term easements were required for the placement and future maintenance of LWD structures. ***Therefore, Alternative Measure 9 was eliminated from the recommended plan and was not considered further.***

The complete set of design plans and the MCACES cost estimate for the 35% level design of the recommended plan are included in Appendix E. The design drawing and cost estimate reflect all of the modifications to the alternative measures described above, and represent the recommended plan that will move forward from the feasibility phase to the plans and specifications phase.

### 4.3 Construction Phasing

The local sponsor (Kitsap County) is currently planning to implement the recommended plan in two phases. The first phase would include construction of the recommended culvert improvement at the South Kingston Road crossing in addition to the habitat features identified as Alternative Measure 7 (fill scour holes) and Alternative Measure 8 (riparian planting). The second phase would include construction of the recommended culvert improvement at the West Kingston Road crossing in addition to the habitat features identified as Alternative Measure 5 (abandoned roadbed excavation), and Alternative Measure 8 (riparian planting). The local sponsor has acquired grant funding for the local cost-sharing portion of the first phase of the recommended alternative and is actively seeking funding for the second phase.

### 4.4 Design and Construction Considerations

### *4.4.1 Construction Considerations - South Kingston Road*

Construction considerations for the improvements at South Kingston Road include temporary access and staging areas, traffic control and stage construction, and diversion of water and erosion control.

4.4.1.1 Temporary Access and Staging Areas

Temporary construction easements would need to be obtained from several private property owners on both sides of South Kingston Road in order to accomplish construction activities, such as cofferdam, erosion control, excavation, fill and revegetation.

A potential staging and stockpiling area is located on property owned by Kitsap County Roads Department, located at the southwest corner of NE West Kingston Road and NE Norman Road NE (see real estate maps in Appendix F). However, the available footprint is only 15,000 square feet. Since it is estimated that approximately 65,000 square feet will be necessary for staging and stockpiling during construction of the South Kingston Road bridge, other sites need to be identified. One such site is Arness Roadside Park (5,400 square feet), located on South Kingston Road adjacent to the construction site. It is also likely that limited amounts of staging can occur within the South Kingston Road NE right of way. Other potential staging and stockpiling sites need to be identified during future design phases.

4.4.1.2 Traffic Control and Stage Construction

Stage construction on South Kingston Road would require closing one lane of traffic at a time to do the construction activities associated with that lane. Temporary shoring, falsework, and shoulder barriers would be required to construct the bridge, channel, and roadway improvements for each lane. The stage construction process would result in approximately 16 weeks of single lane traffic.

The traffic control on South Kingston Road would require a temporary signal system for 24-hour operation and at least two flaggers during construction hours. These traffic control requirements are based on stage construction in order to keep one lane open to traffic during the improvements. All local property owners would still have access to their driveways. Thru traffic would incur delays due to construction traffic and a single lane road at the crossing. Through traffic may avoid these delays by using Miller Bay Road, West Kingston Road, and/or Hwy 104 as detour routes. While every effort would be made to keep at least one lane open at all times, there may be the occasional need to close the road for a short period of time in order to mobilize large equipment, place project elements, or to switch to the next construction stage. Kitsap County would have ultimate authority in allowing for any such road closure, and may require the contractor to perform any activities that would require road closure during non-peak traffic hours.

4.4.1.3 Diversion of Water and Erosion Control

During construction on South Kingston Road, a hydraulic connection equivalent to existing conditions be maintained between Carpenter Creek estuary and Appletree Cove will be required. The construction contractor would ultimately provide the final plan for the diversion, based on permit requirements; however, a potential diversion plan is discussed here and is shown on Plate C10 in Appendix E.

A temporary sheet pile cofferdam would be installed parallel to the proposed bridge, approximately 10 feet beyond the bridge perimeter, and would connect to either side of the existing box culvert. A temporary cofferdam would be installed on both sides of the roadway, and the existing box culvert would be used as the bypass. Due to the daily tidal fluctuations, the temporary cofferdam is required to allow for the construction of the channel improvements in the dry. The cofferdam is not necessarily required for construction of the bridge elements, although due to the staged construction process, the cofferdam will be in place during the construction of the bridge superstructure and the bridge abutments. The proposed design assumes that the bridge foundation would be constructed before placement of the temporary cofferdam. Therefore, the temporary cofferdam will not be in place throughout the entire construction process. Plate G3 in Appendix E presents the suggested construction sequence.

It is anticipated that the sheet piles will be vibrated into place. Dewatering of the construction area would be accomplished by pumping excess water to a percolation basin, or desilting tanks so that the water is treated before being discharged into Appletree Cove. Silt fencing and gravel bags would be placed below or downstream of any construction activity in order to stop any sediment and/or debris from entering the estuary. The cofferdam and existing culvert would be removed after the completion of the bridge and the interior channel improvements, however the erosion control measures should remain in affect until the scour holes are filled and all construction and revegetation is complete for South Kingston Road.

During the development of the 35% design, consideration was given to a construction sequence at South Kingston Road that would not require the use of temporary sheet pile cofferdams to maintain continuous dry conditions for the channel improvements. Under this scenario, the channel work would instead be conducted during consecutive days of low tides, when tides were anticipated to be lower than the proposed channel invert for a minimum of five consecutive hours per day. The existing box culvert would be utilized as the bypass through the embankment. Staged construction of the road would still be required, and therefore, temporary shoring along the centerline of the roadway would still be required. During each day, a certain amount of channel improvement would occur leaving the existing box culvert exposed.

This construction approach for the South Kingston Road bridge was, however, ultimately not recommended and included in the 35% design for two reasons. First and foremost, the construction window is currently still not firmly established, pending completion of the Biological Assessment and Endangered Species Act consultation with USFWS and NOAA Fisheries Service. As summarized in Section 5.3, at this time, the most restrictive estimate of the available construction window is 60 days. Given that this construction window is less than the estimated time of construction needed for the South Kingston Road improvements (16 weeks), proposing construction of all channel improvements during only periods of low tide would be technically very difficult and would likely extend the construction of the South Kingston Road crossing into a second year. A conservative approach, using temporary sheet pile cofferdams for continuous water control, would have a higher chance for success within a single construction season. Secondly, there was concern about maintaining erosion control on the construction site once the existing culvert's sides were excavated and exposed.

### *4.4.2 Construction Considerations – West Kingston Road*

Construction considerations for the improvements at West Kingston Road include temporary access and staging areas, traffic control and stage construction, and diversion of water and erosion control.

4.4.2.1 Temporary Access and Staging

Temporary construction easements would need to be obtained from several property owners on both sides of West Kingston Road in order to accomplish construction activities, such as cofferdam placement, erosion control, excavation, fill and revegetation. Temporary construction access easements would need to be obtained from at least one property owner north of West Kingston Road in order to accomplish construction activities associated with the historic roadbed embankment excavation and removal.

A potential staging and stockpiling area is located on property owned by Kitsap County Roads Department, located at the southwest corner of NE West Kingston Road and NE Norman Road NE (see real estate maps in Appendix F). However, the available footprint is only 15,000 square feet. Since it is estimated that approximately 65,000 square feet will be necessary for staging and stockpiling during construction of the West Kingston Road bridge, other sites need to be identified. One such site is Arness Roadside Park (5,400 square feet), located on South Kingston Road. Since West Kingston Road was recently widened and channelized, staging within the West Kingston Road right of way will likely not be allowed. Other potential staging and stockpiling sites need to be identified during future design phases.

4.4.2.2 Traffic Control and Stage Construction

The traffic control on West Kingston Road would require closure of the road during improvements based on open cut construction. The road would be closed to all non-construction traffic for several hundred feet on each side of the crossing. All local property owners would still have access to their driveways, however, all through traffic would be required to use Miller Bay Road, South Kingston Road, and/or Hwy 104 as detour routes.

Based on open cut construction on West Kingston Road, stage construction would not be required. However, the open cut construction process would require approximately 8 weeks of complete road closure; Miller Bay Road, South Kingston Road, and/or Hwy 104 would be used as detour routes.

4.4.2.3 Diversion of Water and Erosion Control

During construction on West Kingston Road, maintenance of a hydraulic connection equivalent to existing conditions between the upper lobe of the estuary and the main lobe of the estuary will be required. The construction contractor would ultimately provide the final plan for the diversion based on the permit requirements, however a potential diversion plan is discussed here and is shown on Plate C11 in Appendix E.

A PortaDam (http://www.portadam.com/) cofferdam system is proposed for the West Kingston construction work; the PortaDam would be installed approximately 50 feet beyond the bridge perimeter and a 5-foot diameter HDPE pipe would be used to bypass water. The PortaDam system includes steel support structures overlain with a waterproof nylon fabric membrane.

Dewatering of the construction area would be accomplished by pumping excess water to a percolation basin, or desilting tanks so that potentially turbid water does not return directly to the estuary. Silt fencing and gravel bags would be placed below or downstream of any construction activity in order to stop any sediment and/or debris from entering the estuary. The cofferdam and bypass pipe would be removed after the completion of the bridge and the channel improvements, however, the erosion control measures should remain in affect until all construction and revegetation is complete for West Kingston Road.

### 4.5 Operation and Maintenance Considerations

The objective of all operation and maintenance (O&M) procedures is to maximize planting survival, to restore structures to as-built conditions, and/or to adjust structures that are adversely affected by hydraulics. Operation and maintenance costs were calculated for the first year, years 2 through 5, and year 6 through the project lifetime of 50 years for the selected restoration plan. These costs were based on both average O&M costs for plantings and a percentage of construction costs for structures that may experience damage from hydraulic forces, weather, and normal wear and tear due to everyday use. Preliminary operation and maintenance cost estimates for the selected restoration project are discussed below and are shown in Table 10.

Planting operation and maintenance costs are generally incurred in the first five years for the maintenance of tree guards and supports, fertilization, and replacement of non-surviving plants. The O&M costs were developed based on 75 percent survival rate for the first 5 years. The O&M costs were estimated as follows; 15% of the total planting cost over the first year, 2.5% of the total planting cost per year for years two through five. The operation and maintenance of the plantings are typically guaranteed by the contractor for the first year of establishment, however these costs are estimated in Table 10.

Following a flood event or extreme tidal/wave action some erosion control efforts may be required to maintain channel stability at the roadway and channel embankment locations. The regular maintenance and inspection would be rolled into the current maintenance programs for South and West Kingston Roads. Operation and maintenance costs for roadway and channel improvements are generally incurred over the life of the elements. The O&M costs were estimated based on 1% of the total construction costs per year over the lifetime.

The bridges would require periodic debris removal and other regular maintenance and inspections that would be absorbed into the current maintenance program for South and West Kingston Roads. Operation and maintenance costs for bridges are generally incurred over the life of the structures. The O&M costs were estimated based on 0.5% of the total structure costs per year over the lifetime.

Assuming a 5.875% federal discount rate, the total present worth of the 50-year operations and maintenance schedule is $75,100 for Phase I and $50,100 for Phase II. These estimates of present worth are equal to an average annual equivalent cost of $4,700 for Phase I and $3,100 for Phase II.

**Table 10. Preliminary Operation and Maintenance Cost Estimates**

| Item Description | Construction Cost | Year 1 Ann. $ | Year 2-5 Ann. $ | Year 6-50 Ann. $ |
|---|---|---|---|---|
| **Phase I** | | | | |
| Plantings | $27,210 | $4,080 | $680 | - |
| Road/Channel Banks | $145,500 | $1,460 | $1,460 | $1,460 |
| Bridge Structure | $570,040 | $2,850 | $2,850 | $2,850 |
| **Phase II** | | | | |
| Plantings | $86,100 | $12,920 | $2,150 | - |
| Road/Channel Banks | $62,960 | $630 | $630 | $630 |
| Bridge Structure | $258,100 | $1,290 | $1,290 | $1,290 |

## 4.6 Habitat Monitoring Plan

This section provides an outline and guidance for the development of a monitoring plan to evaluate the results of the implementation of the recommended plan for the Carpenter Creek estuary restoration project. The available budget and staffing of the local sponsor may act as a constraint in terms of the level of detail of the monitoring plan. Therefore, this section should be considered a draft monitoring plan to be used by governmental and agency staff in developing a feasible plan that can be implemented within available budget.

Typical goals of a monitoring plan are threefold:

1. Determine if the restoration project was constructed according to the design and permit conditions.
2. Determine if project objectives are being met, if restoration actions are having the desired effects, and if the original assumptions made were correct.
3. Provide guidelines for response actions in the event that objectives are not met, actions do not have the desired effect or assumptions were false.

Objectives for this restoration project are to restore more natural hydrologic/hydraulic conditions that will naturally create and maintain key habitat for fish and wildlife; restore natural sediment and detritus exchange between Appletree Cove and the Carpenter Creek estuary, and through the West Kingston Road embankment; and improve habitat conditions within the estuary. Restoration measures proposed to achieve these objectives include replacing the culverts through the South Kingston and the West Kingston Road embankments with clear span bridges, minor excavation to remove an old roadbed in the upper lobe of the estuary, filling in deep scour holes upstream and downstream of South Kingston Road, selective removal of invasive plant species combined with riparian and saltmarsh revegetation. Together, these restoration measures will result in the restoration of increasingly more natural hydrologic regimes, native vegetation communities, and sediment supply and transport, while also improving salmonid access and productivity, habitat diversity, habitat connectivity, and water quality.

Three primary monitoring tasks will be employed, including those intended to monitor processes, those intended to monitor for conditions and functions, and those intended to monitor for biological response. Additionally, three phases of monitoring will be necessary. Monitoring phases include pre-project baseline, construction and post-project. Throughout each of the three monitoring phases, each of the three monitoring tasks will be used.

The monitoring tasks and phases are defined in the following subsections.

### *4.6.1 Monitoring Tasks*

Process Monitoring

This monitoring task is designed for evaluating the success of restoring natural processes. The two primary processes that are to be restored include the natural tidal inundation process and the sediment supply and transport process.

Conditions Monitoring

This monitoring task is designed for evaluating specific conditions or functions within the project site. Conditions and functions include the physical characteristics of the project site, and include hydrologic conditions (inundation depth and frequency of inundation), hydraulic conditions (average velocities through the improved openings), geomorphic conditions (sediment accretion and sediment erosion) and biological conditions (percent cover of vegetation).

Biological Monitoring

This task is intended to monitor the biological response in the project area, including increased or decreased fish and wildlife species population and increased or decreased fish and wildlife species diversity. Biological monitoring can also include tasks to monitor the changes in plant species population and diversity.

### *4.6.2 Monitoring Phases*

Baseline Monitoring

This monitoring phase should occur prior to project implementation, and should include all three monitoring tasks. Baseline monitoring is conducted to determine the existing conditions of processes, conditions, and biological communities and/or populations. The existing conditions will be compared to the post-project monitoring conditions as a means of determining changes that have resulted from implementation of the project.

To some extent, baseline observations of the hydrologic/hydraulic processes, and determination of baseline extent of plant communities was conducted during the feasibility phase of this project. However, baseline sediment transport processes are not directly known, although limited amounts of information can be inferred from the estimated volume of the scour holes at South Kingston Road. While water quality data has been collected in Carpenter Creek (Cutthroats et. al. 2001), there has no continuous water quality monitoring within the estuary itself. Finally, the use and abundance of fish populations in the estuary is not directly known.

Therefore, more baseline monitoring of geomorphic, water quality, and biological conditions would be warranted prior to construction.

The baseline hydraulics of the current culvert openings is documented in Sections 3.1.1 and 3.2.2 of Appendix C (Hydrology and Hydraulics Appendix), and in Section 2.3 of this report. These sections of the report and appendices present the results of field observations during several tidal cycles, and the results of calibrated hydraulic modeling of the estuary and the existing culverts. The data was used to develop existing condition velocity exceedance curves for both culverts for an average tidal cycle, and to determine the magnitude of the tidal stage attenuation caused by South Kingston Road culvert. Additionally, the hydraulic modeling results were used to compute the volume of the tidal prism allowed by the existing culvert openings during both an average tidal cycle and the historical high tide cycle, and to quantify the area of upstream inundation during both an average tidal cycle and the historical high tide cycle.

Construction Monitoring

As the preferred alternative or alternatives are implemented, construction practices, results, and impacts on surrounding environments should be monitored to ensure that the alternative is built according to design, and that all permit conditions and conservation measures are being met. The duration of this monitoring task is limited to the duration of the construction window.

Post-Project Monitoring

This monitoring phase has the longest duration of the three phases, and is designed to allow ecologists and engineers to determine if the as-built project has achieved its restoration goals. Post-project monitoring begins immediately after construction and can continue for several years or decades. During this monitoring phase, adaptive management techniques should be employed in the event that goals are not being met, and/or assumptions were false. Adaptive management is briefly explained in the following section.

### *4.6.3 Adaptive Management*

Adaptive management is defined as the decision-making process that is used to optimize the successful long-term implementation of any project. The objective of adaptive management for a restoration project is to ensure that processes, functions and habitat values affected by the project are restored in the intended direction and that overall project effects continue to be positive for the natural environment. Key components of adaptive management are identifying indicators for ecological functions and habitat values, monitoring the indicators, setting measurable objectives for the indicators, and planning and implementing remedial actions. The adaptive management process provides a mechanism by which remedial actions can be implemented if a measurable objective is not achieved.

An Adaptive Management Team (AMT), convened by either the Corps or Kitsap County, would direct and implement the adaptive management process during project construction and post-project monitoring. The AMT would consist of members with appropriate technical expertise representing the Corps, Kitsap County, U.S. Fish and Wildlife Service, NOAA Fisheries, WDFW, and other interested parties. If necessary, the AMT would have the authority to address the failure of the project to meet intended objectives, based on the monitoring results. This authority could be defined as a majority or consensus process, and would be subject to any necessary regulatory approvals. Project features could ultimately be reconfigured through these processes. For example, if opening up the roadway embankments of South and West Kingston Roads does not facilitate the transport of excess sediment out of the creek and estuary, additional grading within the estuary could be considered by the AMT. Decision making could include the following response actions:

- No Action
- Maintenance
- Project or Objectives Modification
- Adaptive Management: Reconfiguration of Project Features
- Documentation and Reporting
- Dissemination of Results

A periodic monitoring report should be prepared by the monitoring entity and submitted to the AMT for review. For example, annual reports would summarize monitoring data collected during the previous water year (October 1-September 31). Monitoring reports would be the primary tool by which the AMT would make determinations for response actions.

### *4.6.4 Monitoring Task Indicators*

Determining the success of the restoration alternatives will require monitoring of processes, conditions and biological responses both prior to construction and for a minimum of 5 years following project implementation. A 10-year monitoring period was assumed for the development of this draft monitoring plan.

Monitoring processes, conditions and biological responses can be conducted through physical and biological surveys. These surveys allow several indicator species or conditions to be evaluated both before and after project completion and will provide the data required for the AMT to determine if objectives are being met or how best to respond to failed objectives. Common monitoring indicators include physical measurements of riparian vegetation cover or water temperature, or biological surveys for fish or wildlife species. A number of monitoring indicators are proposed in this section. However, additional indicators or their numeric targets may be identified or modified by the AMT at any time during the monitoring period.

The following monitoring tasks will be further defined following review of this draft plan. The following is a list of potential monitoring indicators, their definition, and if appropriate, their numeric targets for this monitoring plan.

Tidal Inundation and Habitat – Process Indicator

The extent of tidal inundation of the project area should be determined in acres. As a result of the hydraulic modeling conducted for this feasibility report, the baseline tidal inundation area was estimated as 32.2 acres for the average tidal cycle (defined in Appendix C – Hydrology and Hydraulics) and 38.8 acres for the highest tide cycle of record. These acreages were computed based on modeling results that provided the tidal elevation in the estuary upstream of both South

Kingston Road and West Kingston Road at the peak of each of the two tide cycles. The modeled tidal elevations were then used with the topographic mapping of the estuary to determine the tidal inundation area within the entire Carpenter Creek estuary.

Post project determination of the tidal inundation area should be determined after the first year of the implementation of the project (Year 1). This post project determination should be done during a tide cycle that has a peak tidal elevation of approximately 12 feet (MLLW). Tidal elevations can be measured by installing staff gauges upstream and downstream of the road crossings and manually recording the observations. Alternatively, pressure transducers can be used at the same locations to continuously monitor and record the tidal elevations. Since the hydraulically restrictive culverts will have been removed, the post-project tidal elevations upstream of each of the two road crossings should be equivalent to the tidal elevation observed on the Appletree Cove side of South Kingston Road. The tide elevation in the estuary at the peak of the tide can then be used along with the topographic mapping of the estuary to determine the post-project tidal inundation area within the entire Carpenter Creek estuary

Tidal inundation has a direct effect upon the evolution and development of estuarine habitat types. As part of the monitoring plan, the mapped areas of each habitat type (tidal channel, mud flat, low salt marsh, high salt marsh, and freshwater marsh) should also be determined. During the development of this feasibility report, acreages of tidal channel, mudflat, salt marsh were approximated using GIS software, aerial photography and groundtruthing. Refer to Section 3.4 (Habitat Benefits Analysis) for a discussion of the methodology used. The acreages presented in Section 3.4 can therefore provide the baseline determination of habitat type. In odd numbered years following construction (Years 1, 3, 5, 7, 9 for example), identical mapping procedures can be used to determine the extent of change in the acreages of the various habitat types. The habitat benefit analysis conducted for this feasibility report estimated the change in acreage of various habitat types that may be expected as a result of implementation of each alternative measure, and these could be used as the numerical target.

Sediment Accretion/Erosion – Process Indicator

The enlargement of the openings through both road embankments will affect the sediment transport capabilities of the estuary system. Changes in channel planform, channel profile and the topography of the mudflats are expected. To monitor these changes, it is recommended that hydrographic cross sectional surveys be periodically conducted. In addition, elevation surveys may be concurrently conducted within marsh or mudflat areas to further augment sediment accumulation/erosion data.

Prior to construction, specific locations should be selected within the project area where the hydrographic cross-sectional surveys are to be conducted. The aerial topographic survey that was conducted for this feasibility analysis could be used to develop the baseline cross sectional data. However, if funding were available, it would be beneficial to develop true cross section surveys at each of the selected monitoring locations.

Candidate hydrographic survey cross-section locations for pre- and post-project monitoring are shown in Figure 16. Candidate locations were chosen to monitor the local effects of increasing the size of the openings through the two roadway embankments. Final determination of the location and number of cross section survey locations is up to Kitsap County. The results of the cross section surveys can also be used to develop profile plots of the Carpenter Creek thalweg. These profile plots can then be used to document the geomorphic response of the culvert replacement portions of the project.

Post-project monitoring is recommended to be scheduled for years 1, 3, 5, but may likely include years 7 and 10 if restoration of natural sediment transport processes takes several years.

Riparian and Salt Marsh Vegetation – Condition Indicator

Riparian and salt marsh vegetation plantings should be evaluated for percent cover and overall percent survival. Generally, post-project monitoring of plant communities is scheduled for selective years (typically Years 1, 2, 5 and 10). Percent cover in the riparian zone should generally be in the range of 40-60% by Year 1, 75% by Year 2 and 80-90% by Year 5. Irrigation of plantings may be necessary for up to 3 years. Monitoring should occur during the August-September timeframe to account for the maximum growth during the growing season. A possible numeric target may be the extent of mortality. If greater than 20% of plantings fail within the first year, replanting may be the action response of the AMT. The presence of non-native, invasive species should also be documented and included in the monitoring report.

In marsh communities there will be limited new plantings. It will be necessary to determine the marsh vegetation coverage prior to and after construction via transect surveys. Numeric targets may be identified as percentage growth in coverage per year or a diversity index of the plant community. Failure to meet those numeric targets could potentially result in the AMT taking action to plant additional marsh species.

Water Quality – Condition Indicator

Potential water quality indicators are numerous, but the most appropriate indicators for the project area include temperature, turbidity, pH, and dissolved oxygen. Numeric targets for these parameters should be set according to Washington State surface water quality standards (WAC 173-201). Although salinity is not a true water quality parameter, it too should be included as a parameter in the monitoring program.

It is recommended that water quality be monitored at least once per year (for Years 1, 3, 5, and 10) at several locations throughout the estuary, and at a minimum, should include the aforementioned parameters. Equipment is available that will allow for the continuous monitoring and recording of all of these parameters, and can therefore be used to collect data throughout the duration of complete tide cycles. Candidate locations for water quality monitoring stations are shown in Figure 16. Final determination of the location and number of water quality monitoring stations is up to Kitsap County.

Salmonid Access and Use – Biological Response Indicator

There are many approaches to assessing fish use of the project area. Trapping, seining, or visual surveys for presence of adults, juveniles or redds are possibilities. It is recommended that a baseline survey be conducted prior to construction and yearly post-monitoring surveys be conducted during selected years (Years 1, 2, 4, 7, and 10). Beach seining is recommended once per month for the months February through July, inclusive. Sampling should be done in locations that fish would be expected to use and in areas recently opened to fish access through implementation of the restoration project.

Velocity measurements through the new bridge openings should be used as a condition indicator, in conjunction with the field surveys, to assess fishery use of the estuary. While baseline determination of velocities through the existing openings was not directly measured as part of this feasibility study, existing condition velocities were determined using the calibrated hydraulic model developed for this project. Figure 9 in Section 2.3 of this report shows the velocity exceedance curves for the baseline conditions (pre-project) for each culvert opening.

Velocities through the improved West Kingston Road opening are expected to be small (less than 0.5 feet per second) throughout the duration of all tide cycles, and therefore may need to be measured only once during the post-project monitoring period as a verification of the predictive hydraulic modeling. Velocities through the improved South Kingston Road opening are more critical to juvenile salmonid access to the estuary and are expected to be closer to the 1 foot per second threshold (Bottom, et. al. 2001). Therefore, it is recommended that velocities through the South Kingston Road opening be measured during post-project Years 1, 2, and 4. It is further recommended that velocity measurements through both openings be conducted during a tidal cycle that has a peak tidal elevation of approximately 12 feet (MLLW), to verify the predictive hydraulic modeling results. The hydraulic modeling of the improved South Kingston Road opening predicted a maximum average velocity of approximately 1.5 feet per second during the average tide cycle. Refer to Appendix C (Hydrology/Hydraulics) for a definition of the average tide cycle and the predicted velocity exceedance curves for the post-project condition.

Velocity measurements should be made across the width of each bridge opening, and an average cross sectional velocity should be quantified. Measurements should be conducted at regular intervals throughout the duration of the tide cycle.

<u>Wildlife Use – Biological Response Indicator</u>

As with monitoring of fish, there are several methods available for monitoring wildlife species, but in this case there are also several different taxa that may be surveyed. Breeding birds, small mammals, amphibians and macroinvertebrates are all possible indicator species for the project area. Scat surveys and trapping are possible for determining populations for small mammals, while point counts and mist netting are options for bird surveying. Macroinvertebrates are typically assessed using an index of biotic integrity and visual surveys are conducted for amphibians. Specific survey methods, numeric targets and survey species will be selected following review of this draft plan. It is recommended that a baseline survey be conducted prior to construction and yearly post-monitoring surveys be conducted during selected years (Years 1, 2, 4, 7, and 10).

### *4.6.5 Monitoring Plan Cost Estimate*

Estimated annual costs for each of the six monitoring task indicators are summarized in Table 11. Since none of monitoring task indicators will be monitored every year, the estimated annual cost for each indicator is only for the year that monitoring occurs for that indicator. For example, monitoring of the sediment accretion/erosion indicator is expected to cost $5,120 per year, however, this indicator is identified to be monitored only during Years 1, 3, 5, 7, and 10.

The cost of the monitoring plan is based on the assumption that County staff will be conducting all of the monitoring work, and hence, County labor rates were assumed, and were increased by fifty percent to account for County overhead. It is likely that the County will be utilizing an extensive network of volunteers from the Stillwaters Environmental Education Center, the Kitsap County Stream Team and the Suquamish Tribe throughout the duration of the monitoring plan. The use of appropriate volunteer labor will be a cost savings for the County, however, since it is not known exactly how much volunteer labor will be used, it was not factored into the cost estimate presented in the following table.

Assuming a 5.875% federal discount rate, the total present worth of the 10-year monitoring plan is $152,200. This estimate of present worth is equal to an average annual equivalent cost of $9,500 when spread over the 50-year period of analysis. The average annual equivalent cost over the 10-year monitoring period is $20,600.

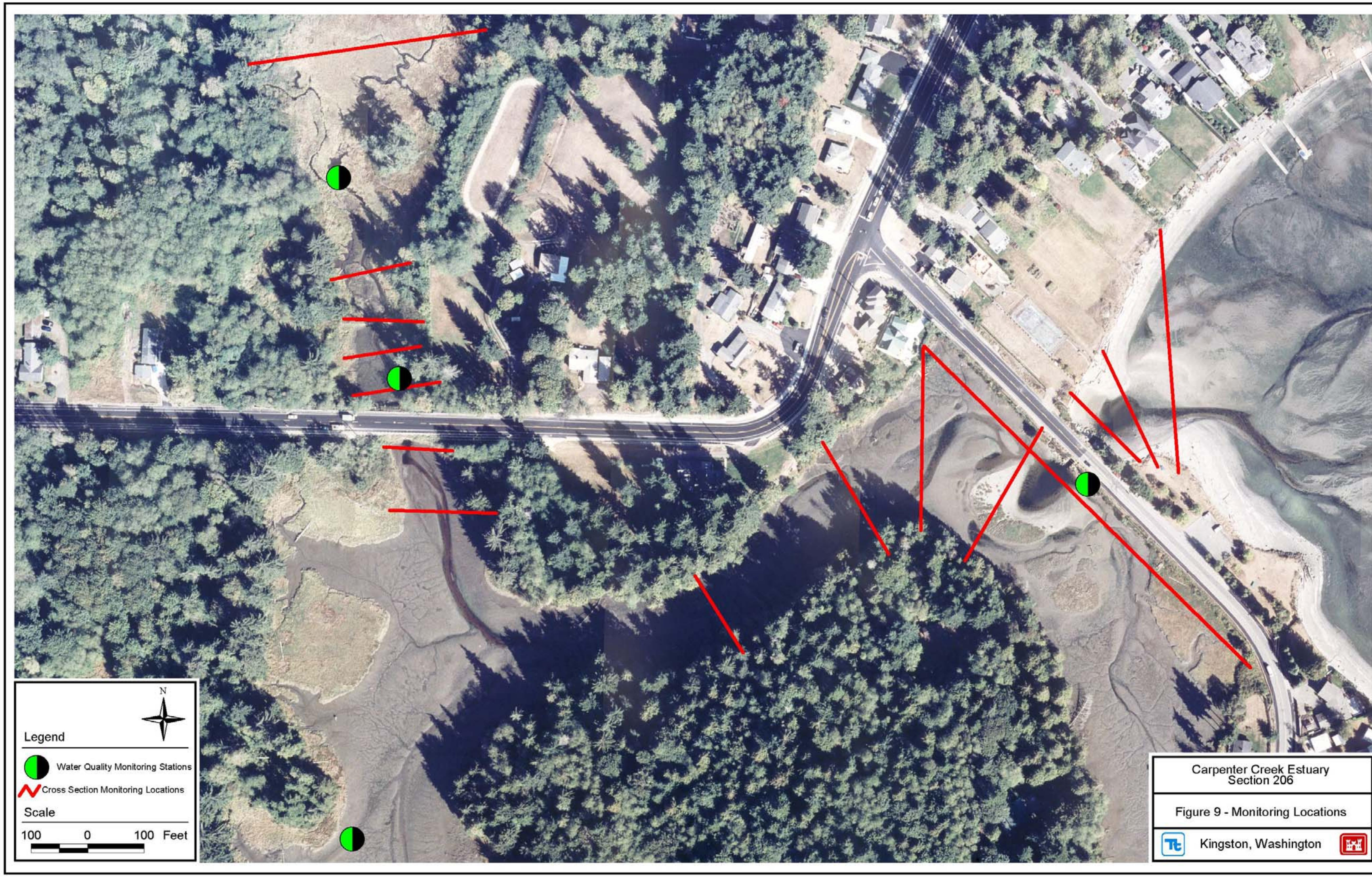


**Figure 16. Potential Monitoring Locations**

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# Table 11. Annual Costs for Carpenter Creek Monitoring Plan

**CARPENTER CREEK ESTUARY SECTION 206 RESTORATION PROJECT**
**MONITORING PLAN COST ESTIMATE**

| MONITORING TASK INDICATOR | ENGINEER *$60/hr* | BIOLOGIST *$45/hr* | TECHNICIAN *$45/hr* | SUBTOTAL | NOTES |
|---|---|---|---|---|---|
| TIDAL INUNDATION AND HABITAT (YEARS 1,3,5,7,and 9) | | | | | |
| a. Tidal Elevations | 8 | | 8 | $840 | |
| b. Habitat mapping | 8 | 16 | 32 | $2,640 | |
| c. Ground-truthing | 8 | 8 | 8 | $1,200 | |
| d. Report preparation | 4 | 8 | 16 | $1,320 | |
| e. Aerial photography and ODCs | | | | $1,500 | Includes aerial photos and travel |
| ***Annual Total*** | | | | ***$7,500*** | |
| SEDIMENT ACCRETION/EROSION (YEARS 1,3,5,7,and 10) | | | | | |
| a. Cross-section surveys | 20 | | 20 | $2,100 | |
| b. Elevation surveys | 8 | | 8 | $840 | |
| c. Report preparation | 16 | | 16 | $1,680 | |
| d. ODCs | | | | $500 | |
| ***Annual Total*** | | | | ***$5,120*** | |
| RIPARIAN AND SALT MARSH VEGETATION (YEARS 1,2,5, and 10) | | | | | |
| a. Field monitoring | | 16 | 16 | $1,440 | |
| b. Report preparation | | 16 | 16 | $1,440 | |
| c. ODCs | | | | $100 | |
| ***Annual Total*** | | | | ***$2,980*** | |
| WATER QUALITY (YEARS 1,3,5, and 10) | | | | | |
| a. Install probes | 4 | | 12 | $780 | |
| b. Download data | | | 30 | $1,350 | |
| c. Report preparation | 8 | 8 | 20 | $1,740 | |
| d. ODCs | | | | $2,000 | Includes equipment rental and travel |
| ***Annual Total*** | | | | ***$5,870*** | |
| SALMONID ACCESS AND USE (YEARS 1,2,4,7, and 10) | | | | | |
| a. Beach seining for use | | 48 | 48 | $4,320 | 1 day seining each month Feb-Jul |
| b. Velocity measurements | | 12 | 12 | $1,080 | Measure once each year |
| c. Redd surveys in fall | | 32 | 32 | $2,880 | Monthly Sept-Dec |
| d. Report preparation | | 20 | 40 | $2,700 | |
| e. ODCs | | | | $1,000 | Includes equipment and travel |
| ***Annual Total*** | | | | ***$11,980*** | |
| WILDLIFE USE (YEARS 1,2,4,7, and 10) | | | | | |
| a. Monthly observations | | 112 | | $5,040 | |
| b. Report preparation | | 40 | | $1,800 | |
| c. ODCs | | | | $1,000 | Includes equipment and travel |
| ***Annual Total*** | | | | ***$7,840*** | |

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# 5. PLAN IMPLEMENTATION

## 5.1 Non-Federal Responsibilities

A letter request for this Section 206 study was previously submitted by the Kitsap County Department of Community Development to the Corps of Engineers on June 26, 2001. The sponsor has committed to funding the project in two separate phases, and has acquired grant funding for the first phase. Depending upon Federal funding, Phase I construction is scheduled to occur during fiscal years 2006 and 2007. Kitsap County is actively seeking grant funding for the second phase of the project.

Feasibility study funds are initially funded completely by the federal government. However, if the proposed project is approved for implementation, the costs incurred during both the feasibility phase and the plans and specifications phase must be included and shared as part of the total project modification costs. Work-in-kind may be provided by the local sponsor, subsequent to execution of the project cooperation agreement (PCA).

The non-federal sponsor for this project is Kitsap County, and is responsible for:

- Providing 35% of the total project implementation cost
- Providing all lands, easements, rights-of-way, relocations and disposal/borrow areas (LERRD). The total value of all LERRD is credited towards the sponsor's 35% share of the total project implementation cost and the Corps will reimburse the sponsor the amount that the LERRD exceeds the 35% commitment
- Assuming full responsibility for all future project related operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) needs
- Paying 100% of the costs associated with OMRR&R. Section 4.5 of this report summarizes the estimated annual OMRR&R costs and the estimated present worth cost for the 50-year life of the project.

A draft monitoring plan has been prepared as part of this feasibility report. Kitsap County is currently working with the Seattle District USACE on finalizing the monitoring plan based upon the draft presented in this report.

It was assumed that the post project monitoring costs would be funded 100 percent by the non-federal sponsor. However, according to ER 1105-2-100 (USACE 2000), post project monitoring costs may be federally shared with the non-federal sponsor if the monitoring program is clearly defined, justified, and the period of cost shared monitoring does not exceed five years following completion of construction. In this case, the federal share of the monitoring costs shall not exceed one percent of the total first cost of ecosystem restoration features (USACE 2000). Therefore, if federal review of the monitoring plan and cost estimate proposed in this feasibility report determines that it is justified to assume federal contribution to post project monitoring, then a portion of these costs can be included as federal costs.

## 5.2 Recommended Plan Cost Estimate

Following plan selection, the design and cost estimate for the recommended plan was refined from the 10% level of design to the 35% level of design. The 35% level construction cost estimate was developed using the MCACES for Windows software, in accordance with guidance contained in ER 1110-2-1302, *Civil Works Cost Engineering*, and ER 5-7-1, *Total Project Cost Summary*. The effective pricing data is based on the latest available unit price database contained with the software, and are expressed in terms of January 2001 dollars.

The construction cost estimates were subdivided into two phases based on the intent to implement the improvements at South Kingston Road in the summer of 2006 (Phase I) and the improvements at West Kingston Road in the summer of 2007 (Phase II). Price levels were escalated from January 2001 to the anticipated midpoint of construction, assumed to be September 2004 for Phase I and September 2005 for Phase II. The escalation cost factors for fourth quarter fiscal year 2004 and fourth quarter fiscal year 2005 were obtained from EM 1110-2-1304 *Civil Works Construction Cost Index System* (tables revised 30 September, 2002). Separate escalation factors are defined for “Fish and Wildlife Facilities” and “Roads Railroads and Bridges”. Due to limited funding in 2004, the project was delayed and costs may need to be adjusted for later than anticipated construction schedules.

The construction costs for each phase of the selected restoration plan include a 25% contingency. This contingency factor was determined based on guidance presented in ER 1110-2-1302 *Civil Works Cost Engineering*, and is suitable for feasibility level design of a project anticipated to cost less than $10 million dollars. Costs associated with engineering and design (E&D), and supervision and administration (S&A) are assumed to be 15% and 12%, respectively, of the construction costs. Tables 12 and 13 summarize the MCACES output for the Phase I and Phase II construction costs. Refer to Appendix E for more detailed discussion of the design and cost estimates, and for the complete MCACES output.

## Table 12. MCACES Cost Estimate Summary for Phase I

| | Contract Cost | Contingency (25%) | Escalation | E&D (15%) | S&A (12%) | Total Cost |
|---|---|---|---|---|---|---|
| South Kingston Road Restorationm Features | | | | | | |
| Clearing and Grubbing | $8,567 | $2,142 | $919 | $1,744 | $1,605 | $14,977 |
| Excavation - Channel | $9,293 | $2,323 | $997 | $1,892 | $1,741 | $16,246 |
| Fill - Scour Holes | $67,275 | $16,819 | $7,217 | $13,697 | $12,601 | $117,608 |
| Revegetation | $20,047 | $5,012 | $2,150 | $4,081 | $3,755 | $35,046 |
| | | | | | Subtotal: | $183,876 |
| South Kingston Road Bridge | | | | | | |
| Mobilization/Demobilization | $74,388 | $18,597 | $8,259 | $15,187 | $13,972 | $130,402 |
| Traffic Control | $100,255 | $25,064 | $11,131 | $20,468 | $18,830 | $175,747 |
| Diversion | $126,824 | $31,706 | $14,081 | $25,892 | $23,820 | $222,323 |
| Dewatering | $29,570 | $7,393 | $3,283 | $6,037 | $5,554 | $51,836 |
| Erosion Control | $21,583 | $5,396 | $2,396 | $4,406 | $4,054 | $37,835 |
| Demolition | $37,637 | $9,409 | $4,179 | $7,684 | $7,069 | $65,978 |
| Excavation - Bridge | $156,088 | $39,022 | $17,330 | $31,866 | $29,317 | $273,623 |
| Fill - Bridge | $11,067 | $2,767 | $1,229 | $2,259 | $2,079 | $19,401 |
| Erosion Protection | $37,567 | $9,392 | $4,171 | $7,670 | $7,056 | $65,855 |
| Road Improvements | $69,339 | $17,335 | $7,698 | $14,156 | $13,023 | $121,551 |
| Utility Relocations | $22,316 | $5,579 | $2,478 | $4,556 | $4,191 | $39,120 |
| Bridge - CIDH Foundation | $190,938 | $47,735 | $21,199 | $38,981 | $35,862 | $334,715 |
| Bridge - Structure Concrete | $71,661 | $17,915 | $7,956 | $14,630 | $13,460 | $125,622 |
| Bridge - Girders | $156,232 | $39,058 | $17,346 | $31,895 | $29,344 | $273,875 |
| Shoring and Falsework | $90,105 | $22,526 | $10,004 | $18,395 | $16,924 | $157,954 |
| | | | | | Subtotal: | $2,095,837 |
| | | | | | **TOTAL PHASE I** | **$2,279,712** |

## Table 13. MCACES Cost Estimate Summary for Phase II

| | Contract Cost | Contingency (25%) | Escalation | E&D (15%) | S&A (12%) | Total Cost |
|---|---|---|---|---|---|---|
| West Kingston Road Restoration Features | | | | | | |
| Clearing and Grubbing | $19,199 | $4,800 | $2,607 | $3,991 | $3,672 | $34,268 |
| Excavation - Channel | $7,769 | $1,942 | $1,055 | $1,615 | $1,486 | $13,867 |
| Revegetation | $62,130 | $15,533 | $8,437 | $12,915 | $11,882 | $110,896 |
| | | | | | Subtotal: | $159,031 |
| West Kingston Road Bridge | | | | | | |
| Mobilization/Demobilization | $37,194 | $9,299 | $5,193 | $7,753 | $7,133 | $66,571 |
| Traffic Control | $7,285 | $1,821 | $1,017 | $1,519 | $1,397 | $13,039 |
| Diversion | $127,805 | $31,951 | $17,845 | $26,640 | $24,509 | $228,750 |
| Dewatering | $18,363 | $4,591 | $2,564 | $3,828 | $3,521 | $32,867 |
| Erosion Control | $9,730 | $2,433 | $1,359 | $2,028 | $1,866 | $17,415 |
| Demolition | $3,068 | $767 | $428 | $640 | $588 | $5,491 |
| Excavation - Bridge | $65,860 | $16,465 | $9,196 | $13,728 | $12,630 | $117,879 |
| Fill - Bridge | $8,420 | $2,105 | $1,176 | $1,755 | $1,615 | $15,070 |
| Erosion Protection | $28,252 | $7,063 | $3,945 | $5,889 | $5,418 | $50,567 |
| Road Improvements | $17,056 | $4,264 | $2,381 | $3,555 | $3,271 | $30,527 |
| Utility Relocations | $14,878 | $3,720 | $2,077 | $3,101 | $2,853 | $26,629 |
| Bridge - Pile Foundation | $28,544 | $7,136 | $3,986 | $5,950 | $5,474 | $51,089 |
| Bridge - Structure Concrete | $53,808 | $13,452 | $7,513 | $11,216 | $10,319 | $96,308 |
| Bridge - Girders | $103,381 | $25,845 | $14,435 | $21,549 | $19,825 | $185,035 |
| | | | | | Subtotal: | $937,238 |
| | | | | | **TOTAL PHASE II** | **$1,096,268** |

Costs associated with lands, easements, rights of way, relocations, and disposal (LERRD) were not included in the MCACES cost estimate, however, these costs are considered a component of the total project implementation cost. Table 14 presents a summary of the total project implementation costs, which include costs incurred during the feasibility phase, the contract costs, E&D costs, S&A costs, and all estimated LERRD costs. Appendix F of this report contains the real estate maps for the project, and the backup calculations for the LERRD requirements for project implementation.

Section 5.1 of this report detailed the methodology for determining cost allocations. For projects funded under the Section 206 program, the local sponsor is responsible for funding 35% of the total project implementation cost, which includes all associated LERRD costs. The LERRD costs are credited to the local sponsor as part of the 35% contribution, and the remaining contribution can be provided in cash or in-kind services. As seen in Table 14, the feasibility phase costs are cost shared 65% and 35% by the federal government and the non-federal sponsor, respectively. However, assuming a maximum non-federal contribution of 35% for project implementation, and assuming all LERRD costs are 100% incurred by the non-federal sponsor, the resulting cost sharing percentages for the other remaining line items in Table 14 were computed to be less than 35%. For any given fiscal year, the total non-federal contribution is 35%.

**Table 14. Summary of Project Implementation Costs by Fiscal Year**

| | TOTAL | FEDERAL | | | | NON-FEDERAL | | |
|---|---|---|---|---|---|---|---|---|
| | | FY04 | FY05 | FY06 | FY07 | FY04-05 | FY06 | FY07 |
| **Feasibility*** | $360,000 | 340,000 | 20,000 | -- | | -- | -- | -- |
| **Plans and Specifications*** | $395,000 | -- | $70,000 | $325,000 | | -- | -- | -- |
| **Construction**** | $3,244,900 | | | $1,140,600 | $704,300 | | $1,020,700 | $379,300 |
| **TOTALS** | **$3,999,900** | **$340,000** | **$90,000** | **$1,465,600** | **$704,300** | -- | **$1,020,700** | **$379,300** |

*Feasibility and Plans and Specifications costs are initially Federally funded. Once the project is in the Construction Phase, the non-Federal cost share of all phases are computed.
**Construction costs include Contracting, Supervisory and Administration (S&A) and LERRD costs.

Costs associated with operation, maintenance, repair, replacement, and rehabilitation (OMRR&R), which includes costs associated with plant establishment, were also not included in the MCACES cost estimate. These costs were computed outside of MCACES and were described and documented in Section 4.5 of this report. OMRR&R costs are 100 percent funded by the non-federal sponsor.

Costs associated with post-project monitoring were also not included in the MCACES cost estimate. These costs were computed outside of MCACES and were described and documented in Section 4.6 of this report. As previously mentioned, it was assumed that the post project monitoring costs would be funded 100 percent by the non-federal sponsor. However, according to ER 1105-2-100 (USACE 2000), post project monitoring costs may be federally shared with the non-federal sponsor if the monitoring program is clearly defined, justified, and the period of cost shared monitoring does not exceed five years following completion of construction. In this case, the federal share of the monitoring costs shall not exceed one percent of the total first cost of ecosystem restoration features (USACE 2000). Therefore, if federal review of the monitoring plan and cost estimate proposed in this feasibility report determines that it is justified to assume federal contribution to post project monitoring, then a portion of these costs can be included as federal costs.

Table 15 summarizes the federal share and the non-federal share of the total project implementation costs, the LERRD costs, the OMRR&R costs, and the post project monitoring costs for the 10-year monitoring period. The OMRR&R cost and the monitoring cost are expressed as present worth costs for the 50-year life of the project and the 10-year monitoring period, respectively.

**Table 15. Summary of Financial Data**

| | **Total** | **Federal** | **Non-Federal** |
|---|---|---|---|
| **Feasibility** | $360,000 | $234,000 | $126,000 |
| **Plans and Specifications** | $395,000 | $256,800 | $138,200 |
| **Contract Cost (Including Escalation and Contingency)** | $2,621,100 | $1,703,700 | $917,400 |
| **Supervisory and Administration (S&A)** | $361,700 | $235,100 | $126,600 |
| **LERRD** | $143,000 | $24,000 | $119,000 |
| **OMRR&R** | $125,200 | $0 | $125,200 |
| **Monitoring** | $152,200 | $0 | $152,200 |
| **TOTALS** | $4,158,200 | $2,453,600 | $1,704,600 |

## 5.3 Design and Construction Schedule

At the Carpenter Creek site, there are distinct allowable construction windows defined due to the presence of federally and state protected aquatic species and federally protected bird species. In regards to the construction window defined for federally protected aquatic species, the available construction window is July 16th through February 15th. This is based on the potential presence of Puget Sound Chinook and bull trout in the tidal waters in the vicinity of Carpenter Creek estuary and Appletree Cove. In addition, a WDFW construction window for the protection of spawning sand lance may apply to the project. The available construction window for the protection of spawning Pacific sand lance is March 2nd through October 14th.

The nesting season work closure period for the federally protected bald eagle extends from January 1st through August 15th. The wintering season work closure period for the bald eagle extends from October 31st through March 31st. USFWS has indicated that nesting and wintering bald eagles both occur in the project area. Therefore, the available construction window that has been defined for federally protected bird species is August 16th through October 30th.

Based on the closure periods for federally protected aquatic and bird species, as well as state protected aquatic species, a conservative definition of the available construction window for improvements in the Carpenter Creek estuary would be August 16th through October 30h (60 calendar days). However, it may be possible to begin some construction work as early as June 15th if eagle nests in the vicinity are not being used, if USFWS determines that chicks will have begun to fledge by this time, and/or if monitoring during construction activities indicates no impacts to nesting or fledging eagles. Likewise, if sand lance are not found to spawn in Appletree Cove, USFWS may allow some construction to occur during the early part of the eagle wintering period in October and November.

Table 16 summarizes the alternative measures that will be included as part of the Phase I and the Phase II implementation, and Table 17 summarizes the project implementation schedule.

**Table 16. Alternative Measures Included within Each Implementation Phase**

| Alternative Measure | Alternative Measure Description |
|---|---|
| PHASE I | |
| 1 | Replace South Kingston Road culvert with single span bridge |
| 7 | Fill scour holes at South Kingston Road |
| 8 | Implement riparian and estuarine planting plan at South Kingston Road |
| PHASE II | |
| 3 | Replace West Kingston Road culvert with single span bridge |
| 5 | Excavate abandoned roadbed |
| 8 | Implement riparian and estuarine planting plan at West Kingston Road |

**Table 17. Project Implementation Schedule**

| | |
|---|---|
| Planning/Design and Analysis Phase | December 2001 – December 2002 |
| Feasibility Phase | January 2003 – May 2005 |
| Plans and Specifications Phase | June 2005 – January 2006 |
| Advertise for Phase I | March 2006 |
| Construction of Phase I (proposed) | June 15, 2006 – October 30, 2006 |
| Advertise for Phase II | March 2007 |
| Construction of Phase II | August 16, 2007 – October 30, 2007 |

## 5.4 Real Estate Requirements

Property ownership within the project vicinity is primarily held by individual private property owners. However, Kitsap County Parks Department, Kitsap County Roads Department and several limited liability corporations (LLC's) also own property in the vicinity of the project footprint. There are no federally owned lands or former federal projects located in the immediate vicinity of the project area.

Table 18 summarizes the property ownership in and around the Carpenter Creek estuary. Real estate drawings have been prepared in support of this project, and illustrate the spatial relationships between property ownership and the proposed restoration activities. The real estate drawings are included in Appendix F (Real Estate).

**Table 18. Property Ownership within Project Vicinity**

| Property Owner | Ownership Type | Parcel Number | Parcel Size (acres) |
|---|---|---|---|
| A&A Tree Farms, Inc. | Private | 3527022016 | 20.3 |
| Alexander, Cindy G. | Private | 3527021006 | 1.0 |
| Arness, Suzanne T. | Private | 3527022002 | 36.7 |
| Beckmann, Mary P. | Private | 3527021030 | 1.3 |
| Beckmann, Mary P. | Private | 3527021031 | 1.5 |
| Cox, Bobby D. | Private | 43170000490003 | 0.8 |
| Crawford, Patrick | Private | 43170000500009 | 0.7 |
| Hearn, Gary W. | Private | 2627024071 | 0.3 |
| Kaestner, Michael W. | Private | 2627023024 | 1.2 |
| Kekipi, Joan M. | Private | 3527021001 | 1.8 |
| Kingston Terrace Development | Private | 2627023054 | 3.7 |
| Kingston Terrace Development | Private | 2627023055 | 1.9 |
| Kitsap County | Public | 2627023025 | 14.9 |
| Kitsap County Roads Department | Public | 3427021005 | 6.9 |
| Kitsap County Parks Department | Public | 3527021012 | 0.1 |
| Kitsap County Parks Department | Public | 43170000520007 | 0.7 |
| Kitsap County Parks Department | Public | 43170000540005 | 2.2 |
| Knutson, Carol H. | Private | 4317000051 | 0.5 |
| Kurpgeweit, Duke | Private | 2627023029 | 5.9 |
| Landers, David D. | Private | 3527021023 | 1.5 |
| Landers, David D. | Private | 43170000480004 | 0.9 |
| Lee, Randy M. | Private | 3527022004 | 9.2 |
| McClain, Cleon T. | Private | 3527021024 | 1.0 |
| McLellan, Richard H. | Private | 3527021019 | 0.3 |
| North Kitsap County School District | Public | 2627023017 | 35.9 |
| Olympic Property Group, LLC | Private | 3527022025 | 182.6 |
| Palmer, Joleen | Private | 2627023027 | 3.0 |
| Pope Resources Inc. | Private | 3527021005 | 4.0 |
| Pope Resources, Inc. | Private | 2627024043 | 1.0 |
| Prisk, Karl R. | Private | 2627024041 | 0.4 |
| Shoemaker, Michael | Private | 3527022027 | 1.6 |
| Shoemaker, Michael | Private | 3527022028 | 1.5 |
| Talmage, Patricia Ann | Private | 3527021008 | 3.9 |
| Talmage, Patricia Ann | Private | 3527021020 | 1.2 |

There are four types of easements that will be required for implementation and future operation and maintenance of this restoration project. The required easements are defined as:

- **Temporary access easements** - these easements are required to allow the contractor access to the proposed work area. The limits of these easements typically extend between county owned right-of-way and the limits of the temporary work area easement.
- **Temporary work area easements (temporary estates)** – the boundaries of temporary work area easements correspond with the required boundary for construction of a given project element. In cases where the perpetual footprint is large enough to support

construction activities, temporary work area easements may not be required. For this project, work area easements were extended beyond the boundary of perpetual footprints to allow room for the construction operation.

- **Term easements** – term easements are required for project elements that will require short-term post-project operation and maintenance. For this project, a 5-year term easement has been assumed for the footprint of all estuarine and riparian plantings.
- **Fee interest** – this is a perpetual interest, necessary for long-term operation and maintenance of permanent facilities. For this project, the two proposed bridges are the only permanent facilities that will require long-term operation and maintenance.

Table 19 provides a summary of the size of the property interest footprints necessary to support the project. For each type of easement, the amount of required property is indicated, and is further subdivided into property that is currently privately owned and property that is currently owned by the county.

**Table 19. Acreage of Required Easements**

| Ownership Type | Area (Acres) |
|---|---|
| **Temporary Access Easements** | |
| Privately Owned Property | 0.12 |
| County Owned Property | 0.20 |
| Subtotal | 0.32 |
| **Temporary Work Area Easements** | |
| Privately Owned Property | 1.17 |
| County Owned Property | 0.68 |
| Subtotal | 1.85 |
| **Term Easements** | |
| Privately Owned Property | 0.90 |
| County Owned Property | 0.36 |
| Subtotal | 1.26 |
| **Fee Interests** | |
| Privately Owned Property | 0.00 |
| County Owned Property | 0.16 |
| Subtotal | 0.16 |
| **Total of all LER** | **3.59** |

It is assumed that the disposal of all excess materials will occur at a commercial facility, and therefore, acquisition of a suitable disposal site is not necessary for this project. Local, commercial disposal facilities have been identified, and the appropriate costs for off-site disposal are accounted for in the MCACES cost estimate.

Sufficient area for staging of each of the phases of project implementation has not yet been identified. Real Estate Plate R1 (Appendix F) shows the 15,000 square feet of county owned property that has so far been identified for construction staging. However, the anticipated size of the required construction staging area has been estimated to be approximately 65,000 square feet. Therefore, an additional 50,000 square feet of contiguous land area is required for implementation for each of Phase I and Phase II of this project.

Appendix F includes the real estate plates for this project, the backup calculations for the size of the required easements, and the backup calculations for the estimated cost of lands easements and rights of way (LER).

# 6. ENVIRONMENTAL IMPACTS OF RECOMMENDED ALTERNATIVE

## 6.1 Geology and Soils

### *6.1.1 No Action*

The No Action alternative would continue the situation of constricted culverts at South Kingston and West Kingston Roads. However, there would be no effects on geology and soils. Deposition of fine-grained materials would likely continue to occur upstream of West Kingston Road, caused in part by the hydraulic restriction through the road embankment. The localized scour upstream and downstream of South Kingston Road is likely stabilized and is not anticipated to worsen in the future. However, as long as the restrictive culvert is in place in South Kingston Road, the scour holes will remain. The no action alternative's impact on sediment is described in more detail in the geomorphology and sedimentation subsection of this chapter.

### *6.1.2 Recommended Plan*

The recommended alternative includes excavation of beach deposits and alluvial sediment deposits in support of the replacement of the West Kingston Road culverts and the South Kingston Road culverts. At both sites, this excavation would be limited to channel excavation within the road right-of-way, and approximately 5 to 10 feet upstream and downstream of the road right-of-way. The upstream and downstream excavation would provide a transition from the new, slightly lower invert elevation of the single span bridge openings to the upstream channel elevations.

Approximately 200 feet upstream of the West Kingston Road opening, the recommended alternative also includes the removal of approximately 220 cubic yards of fill material that was placed in the estuary (date unknown) in support of an old road crossing. This excavated material would be hauled off-site. The excavated area (approximately 0.2 acres) would be graded and transitioned to match upstream and downstream topography.

In support of the culvert replacements, the recommended alternative also includes the removal of portions of the existing road fill at both South and West Kingston Roads. Approximately 3,500 cubic yards and 1,900 cubic yards of material would be excavated from the South Kingston Road and West Kingston Road fills, respectively. If any of the excavated road fill from South Kingston Road is deemed suitable, it could be used to fill in portions of the scour holes located upstream and downstream of South Kingston Road. The portions of the road fill that are not deemed suitable would be hauled off-site. Filling of the scour holes is described in more detail in the following section.

Overall, the recommended alternative would not have a significant effect on the geology or distribution of soils in the project area.

## 6.2 Geomorphology and Sedimentation

### *6.2.1 No Action*

The no action alternative would continue the existing culvert constrictions at South and West Kingston Roads. The localized scour upstream and downstream of South Kingston Road has reached an equilibrium condition and the geometry of the scour holes will likely not change significantly in the future. However, sediment deposition will continue to occur upstream of West Kingston Road and to a lesser extent, between South Kingston Road and West Kingston Road. Over time, it is likely that the upper estuary, upstream of West Kingston Road, would continue to transition from estuarine habitat into more freshwater marsh habitat as sediment deposition continues. Tidal mudflat habitat would likely disappear from the upper estuary. Sediment sources include the upland Carpenter Creek watershed, shoreline erosion, and suspended sediment transported from Appletree Cove into the estuary during flood tides.

### *6.2.2 Recommended Plan*

Implementation of the recommended alternative would promote more effective sediment export from the estuary and would subsequently slow down the rate of sediment deposition throughout the estuary, specifically in the upper estuary. Increased tidal prism, and increased flow rates associated with the tidal prism, will promote more effective sediment transport out of the estuary. The increased size of the openings at the road crossings will provide for increased effective flow areas and the elimination of ineffective flow areas upstream of the openings.

The recommended alternative proposes to fill the localized scour holes that have developed upstream and downstream of South Kingston Road since the installation of the box culvert. Bathymetric survey of the scour holes was not conducted for this project, and therefore, the bottom elevations of the holes were estimated assuming stable side slopes consistent with the soil textures observed in the subsurface borings. The volume of the upstream and downstream scour holes were estimated to be approximately 1,600 cubic yards and 1,000 cubic yards, respectively. The existing scour holes would be partially filled with imported material, up to an elevation approximately five feet below the top of the scour hole. It is anticipated that coarse sand or very fine gravels would be used, which have sufficient clear water settling velocities that will allow for placement of the material between tide cycles. The remaining upper five feet of each scour hole will be filled with imported materials of similar grain size to adjacent native materials.

All fill activities would be conducted between high tides, when tidal elevations are less than –0.5 feet MLLW. Final grading of the scour hole fill would be allowed to occur naturally, and would be aided by the increased tidal volume and the increased sediment transport capabilities resulting from the larger opening through the South Kingston Road embankment.

The tidal channels upstream of both West Kingston Road and South Kingston Road would be excavated to a minor extent, approximately 5 to 10 linear feet. The tidal channel excavation would be limited to only that required to transition from the new bottom geometry to the upstream channel systems. Upstream of both bridge openings, it can be expected that the size and distribution of tidal channels will increase throughout the estuary and that some salt marsh habitat may be scoured away and replaced by intertidal mudflat habitat. The freshwater wetland habitat upstream of West Kingston Road will partially transition to high salt marsh habitat.

The replacement of the restrictive culverts with larger openings will also allow for the fine sediment that has accumulated over the years to be transported out of the estuary into Appletree Cove and Puget Sound. This process will occur as the channels within the estuary increase in size and distribution en route to a new equilibrium condition. This will not occur quickly or instantaneously, but will take place over the course of many years. At this time, it is not known how much previously deposited material would be transported out of the estuary.

Overall, the recommended alternative would provide a more natural sediment transport regime, thus benefiting geomorphology and sedimentation in the estuary. No significant adverse effects are expected.

## 6.3 Hydrology and Hydraulics

### *6.3.1 No Action*

The no action alternative would continue the existing constricted culverts at South and West Kingston Roads. Tidal exchange would continue to be restricted due to the restrictive size of the culvert openings. Sediment would continue to deposit upstream of West Kingston Road and it is possible that at some time in the future, the culvert could partially fill in with sediment or debris. This could increase flood elevations upstream of West Kingston Road and would further decrease the volume of the tidal prism in the upper estuary.

Average culvert velocities through the South Kingston Road culvert would continue to exceed the 1 ft/s criteria during most tide cycles. During the average tide cycle (see Section 2), results of the baseline hydraulic analysis indicated that ebb tide velocities through the South Kingston Road culvert attained rates as high as 10 ft/s, and exceeded 1 ft/s nearly 80% of the time. The velocity that was exceeded 50% of the time during the average tide cycle was estimated to be between 2.5 and 4 fps.

The no action alternative would therefore not achieve the project purpose of providing fish access to the estuary.

### *6.3.2 Recommended Plan*

The recommended alternative would result in larger openings through each of the road fills. At MHW, the cross sectional area through the South Kingston Road embankment would be increased from approximately 75 square feet to approximately 360 square feet. Likewise, the cross sectional area through the West Kingston Road embankment would be increased from approximately 10 square feet to approximately 50 square feet.

The increased flow areas will allow improved tidal exchange through both road fills. Results of the hydraulic analysis indicate that the tidal prism volume through the South Kingston Road culvert would be increased by nearly 25% during the average tidal cycle. The tidal prism volume through the West Kingston Road culvert would be increased by slightly more than 10% during this same tide cycle.

The increase in tidal volume would result in a gradual modification of the tidal channel network and increase the area of the network. The improved hydraulic connection through the West Kingston Road embankment would reduce sediment deposition in the upper estuary and allow saltwater to move further upstream into the upper estuary. During the average tide cycle, the average velocities through the South Kingston Road bridge opening would be less than or equal to 1 ft/s for approximately 13 percent of the time, thereby allowing unhindered fish access throughout the estuary. During this same tide cycle, the average velocities through the West Kingston Road bridge opening would be less than or equal to 1 ft/s for the entire duration of the tide cycle. Figure 17 shows the velocity exceedance curve for the improved condition at South Kingston Road as compared to the existing condition.

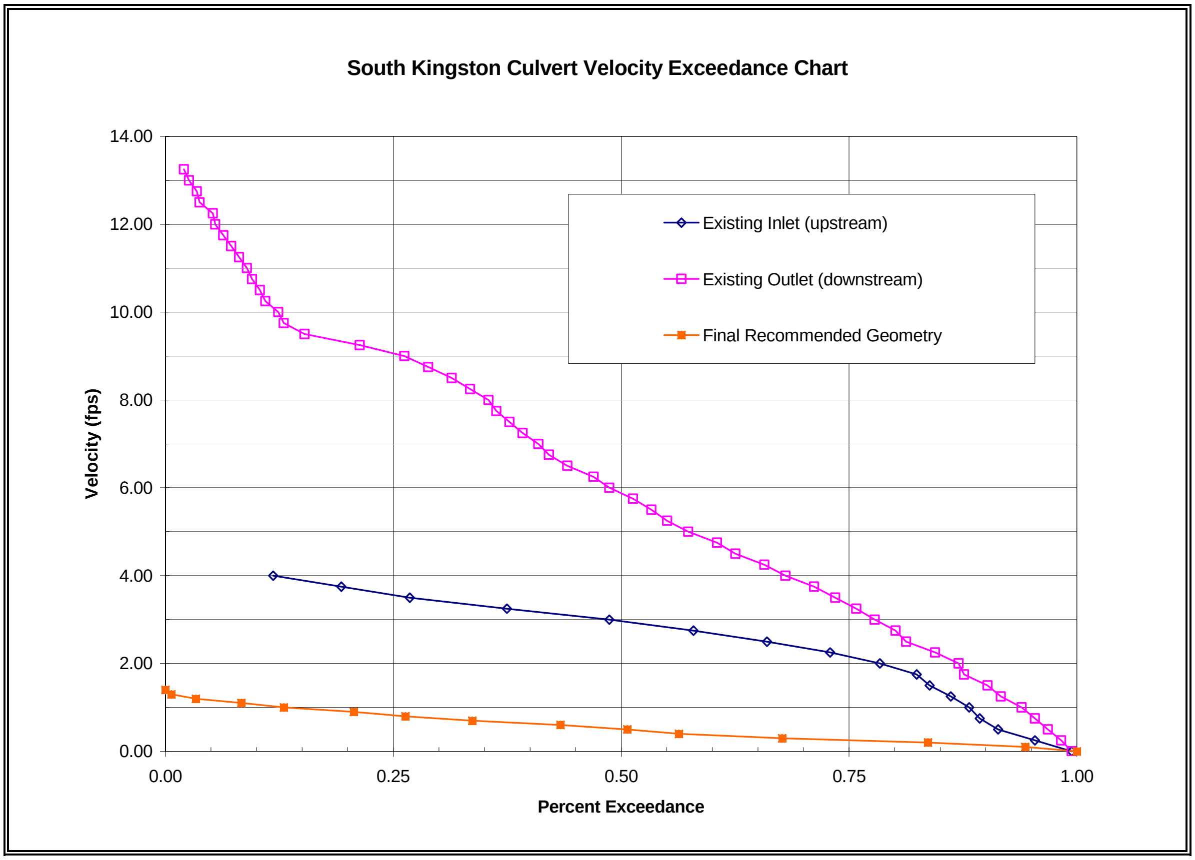


**Figure 17. Velocity Exceedance Curves – Improved Conditions**

For any given tide cycle, the post-project inundation area within the Carpenter Creek estuary will be slightly larger in extent than that associated with the pre-project condition. Since the South Kingston Road culvert offers significantly more hydraulic restriction for tidal waters than does the West Kingston Road culvert, the culvert improvement at South Kingston Road will have the greatest affect on increasing upstream inundation area. Only for the highest tide of record, will land area that has previously not been tidally inundated since the box culvert was installed at South Kingston Road, be inundated. For all other tidal conditions, the duration and frequency of inundation will increase slightly from the pre-project condition.

The amount of land area, which will be affected by, increased inundation duration and increased inundation frequency is small. Hydraulic modeling conducted for this project determined that during slackwater conditions, the existing South Kingston Road culvert attenuated Appletree Cove tidal elevations by only 0.3 feet. Therefore, during slackwater conditions, it is expected that the depth in the Carpenter Creek estuary will increase by 0.3 feet as a result of the improvements. This increase of 0.3 feet of depth corresponds with an increase in land area that will be tidally inundated, and the quantity of the increased land area is a function of the elevation of the specific tide. For the average tidal cycle (12.5 feet MLLW), it was determined that the upstream inundation area at slackwater conditions will be 53,900 square feet greater than existing conditions. For the historical high tide cycle (14.6 feet MLLW), it was determined that the upstream inundation area at slackwater conditions will be 41,400 square feet greater than existing conditions. Refer to Appendix F for the inundation maps and the backup calculations for the increased inundation areas for the average tidal cycle and the historical high tide cycle.

Overall, the recommended alternative would provide a more natural hydrologic and hydraulic regime in the estuary. No significant adverse effects are expected.

## 6.4 Water Quality

### *6.4.1 No Action*

The No Action alternative would continue the condition of constricted culverts at South and West Kingston Roads. The culverts do not significantly affect water quality, although there may be less suspended sediment currently, because of the excess sediment deposition upstream of West Kingston Road. Additionally, dissolved oxygen levels as well as water temperature may be negatively affected by the presence of the culverts due to the reduced flushing flows that they create. Runoff from the roadways would also continue to go into the estuary. This alternative would not accomplish the project purpose.

### *6.4.2 Recommended Plan*

The recommended alternative would not significantly change water quality; however, increased transport of sediment from the estuary can be expected. This would occur slowly over several years due to the increased tidal volume. During a flood, there could be significant levels of suspended sediment. The riparian plantings would slightly improve the water quality of local drainage by intercepting runoff from the roadway in the vicinity of the new bridges. By reducing the constrictions at the road crossings, the estuary will flush more easily and frequently which could incrementally improve water temperatures and dissolved oxygen concentrations.

During construction, cofferdams and silt fences will be utilized to retain sediments that are disturbed within the tidal area. For the road improvement elements of the project, the contractor will be required to implement silt fences and Best Management Practices (BMPs) to prevent sediment-laden runoff from entering the tributary. Filling of the scour holes near South Kingston Road will be conducted during negative tides, however, the perennially flowing Carpenter Creek is not proposed to be bypassed during the filling of the scour holes. Some amount of sediment may therefore be conveyed off site into Appletree Cove.

Overall, there will be minor temporary effects on turbidity, which will be reduced to the maximum extent practicable during construction by the use of BMPs. Over the long-term, there will be no significant adverse effects and there may be slight beneficial effects.

## 6.5 Vegetation and Wetlands

### *6.5.1 No Action*

The No Action alternative would continue the existing constricted culverts at South and West Kingston Roads. The continued sediment deposition in the upper estuary would likely cause slightly more habitats to transition to freshwater marsh habitat. This would likely mean slightly increased areas of creeping bentgrass, reed canary grass and cattails. The freshwater marsh could transition to shrub and forested wetland over the very long-term. Mudflat areas would likely transition to salt marsh dominated by salt grass, tufted hairgrass, and fat hen. This alternative would not accomplish the project purpose.

### *6.5.2 Recommended Plan*

The recommended plan would increase tidal volume and exchange and allow for salt water intrusion further upstream into the upper lobe of the estuary. This would likely eliminate some of the existing freshwater wetland area upstream of West Kingston Road (~0.05 acres). The vegetation would slowly change to being dominated by salt grass, pickleweed, tufted hairgrass and Douglas aster. A few of the closest fringing trees at the creek outlet might die, with alder being primarily affected. Sitka spruce and cedar would likely persist. It can be expected, over time, that small additional areas of salt marsh in both lobes of the estuary would be scoured and converted to mudflat or tidal channel (0.1 acres), and some of the existing mudflat would be converted to tidal channel (0.24 acres). The increase in tidal channel area would increase the area of potential eelgrass habitat. The riparian plantings would improve the fringe of the estuary by removing non-native species and replacing them with native trees and shrubs.

Additionally, to accommodate the raised roadway profile along South Kingston Road, approximately 70 linear feet of the roadway embankment north and south of the new bridge opening (for a total of 140 linear feet) would have to be reconstructed to a slope of 2H:1V. This embankment reconstruction would primarily affect the estuary side of South Kingston Road. The toe of the slope will be constructed with buried riprap up to the mean high water (MHW) elevation. Vegetated soil lifts combined with salt marsh plantings will be used up to one foot above MHW. Above this elevation, riparian plantings will be used to stabilize the roadway embankment. The reconstructed roadway embankment will have a shallower slope than existing, and will therefore result in filling of approximately 700 square feet of existing mudflat habitat. The toe of the new slope will protrude approximately 5 feet further into the estuary than existing for approximately 70 linear feet north and south of the new bridge opening.

Overall, there will be small-scale changes to the distribution of habitats in the estuary, and therefore, the recommended plan is not expected to adversely affect vegetation and wetlands and will convert the estuary into a more natural distribution of habitat types. The adverse effects of filling of the mudflat habitat will be greatly offset by the long-term benefits that the recommended plan will provide.

## 6.6 Aquatic Food Web

### 6.6.1 No Action

The No Action alternative would continue to have low detrital, wood and sediment export from the Carpenter Creek estuary. Export may be further reduced over time with continued sediment deposition. Juvenile salmonids and marine fish would continue to have limited access to the estuary for rearing on the aquatic invertebrates in the system.

### 6.6.2 Recommended Plan

The recommended alternative would greatly improve tidal exchange and allow a significant increase in the export of detritus, wood and sediment from the creek and estuary into Appletree Cove and Puget Sound. This would improve the nearshore marine habitat in Appletree Cove, while the greater tidal exchange would allow unhindered fish access to the estuary. Overall, no significant adverse effects are expected, and beneficial effects will occur.

## 6.7 Fish and Wildlife

### 6.7.1 No Action

The No Action alternative would continue the existing constricted culverts at South and West Kingston Roads. Fish passage would continue to be hindered or blocked altogether, depending on the species. Wildlife movements would also continue to be restricted due to the need to cross the roadways. Over time, the upper estuary would likely transition to more freshwater wetland and intertidal mudflats would be eliminated from the upper estuary.

### 6.7.2 Recommended Plan

The recommended alternative would provide unhindered fish passage throughout the estuary and to the creek. The existing freshwater wetland in the upper estuary would likely transition to salt marsh habitat, but the change would not be significant since the freshwater wetland is currently dominated by species that tolerate slightly brackish conditions. Amphibians would not use estuarine habitat and would lose a small area of potential foraging habitat (unlikely to provide nesting habitat currently). Tidal channel and mudflat habitat would increase, which would provide more rearing opportunities for juvenile salmonids, and potentially increase eelgrass habitat. Salt marsh habitat would slightly decrease, but this would not significantly affect any species. Wildlife migratory corridors would be improved because mammals would be able to pass through the larger bridge openings. The removal of non-native vegetation and replanting with native vegetation would improve riparian habitat for birds and other wildlife. Waterfowl habitat would not be significantly changed from the existing condition. Overall, there should be benefits to fish and wildlife species and no significant adverse effects.

## 6.8 Threatened and Endangered Species

### *6.8.1 No Action*

The No Action alternative would continue the existing constricted culverts at South and West Kingston Roads. This reduces the production of salmonids in the area, which may incrementally reduce foraging opportunities for bald eagles. Otherwise, the No Action alternative would not change conditions for threatened and endangered species.

### *6.8.2 Recommended Plan*

The recommended alternative could affect bald eagles in three ways: 1) disturbance during the construction period; 2) long-term improvement in fisheries due to improved fishery access to the estuary; and 3) improved perching habitat provided by riparian plantings.

Bald eagle is present on a regular basis in the vicinity of Appletree Cove and Carpenter Creek estuary. An existing nest is present within a ½ mile of the estuary and the West Kingston Road crossing (Wiltermood Associates 1999). The project is anticipated to begin construction near the end of the bald eagle nesting season, which extends from January 1st through August 15th. The bald eagle nest location will be reconfirmed prior to the start of construction, and USFWS and WDFW will be contacted to develop Best Management Practices (BMPs) to avoid adverse effects on bald eagles. For the South Kingston Road culvert improvement, the foundation system will be comprised of drilled shafts, and therefore, pile driving will not occur. It is assumed that sheet piles, for both the cofferdam and the slope protection in excavation pits, will be capable of being vibrated into place. Therefore, driving of sheet piles is not expected.

The bald eagle wintering season extends from October 31 through March 31. It is anticipated that construction activities will be completed prior to October 31st, and therefore, will have no impact on bald eagle wintering.

The long-term improvements that will occur in fish habitat and passage should incrementally benefit bald eagles by incrementally increasing fish populations. Plantings of native riparian species will also, over time, improve perching and potentially nesting habitat for bald eagles. Overall, the project should benefit bald eagles and reasonable measures will be undertaken to avoid adverse effects during construction.

The recommended alternative is not likely to adversely affect marbled murrelets or bull trout. Cofferdams and silt fences will be placed upstream and downstream of the roadways during the construction to control offsite sediment. Throughout the duration of the construction of both of the bridges, the hydraulics through the roadway embankments will be maintained at an equivalent level as the existing culverts currently provide. This will be accomplished by the construction of a single bypass pipe through the West Kingston roadway embankment along the alignment of the existing culverts, which will penetrate through the upstream and downstream cofferdams. For the South Kingston construction, the existing 10-foot by 10-foot box culvert will be kept in place throughout construction, thereby providing equivalent hydraulic conditions as currently exist. The cofferdams and the silt fences will prevent increased offsite turbidity. No known habitats utilized by bull trout or marbled murrelets would be modified. After replacement of the culverts at South and West Kingston Roads, it is likely that any bull trout present in the nearshore marine zone would be able to access the estuary unhindered.

A Biological Assessment is being prepared for this project and consultation is ongoing with both USFWS and NOAA Fisheries. The project will benefit essential fish habitat by providing unhindered access to the estuary for chinook salmon. Overall, the project will likely benefit bald eagles and bull trout and have no effects on marbled murrelets.

## 6.9 Cultural Resources

### *6.9.1 No Action*

The No Action alternative would not affect cultural or historic resources.

### *6.9.2 Recommended Plan*

THIS SECTION IS TO BE DEVELOPED BY THE SEATTLE DISTRICT USACE

## 6.10 Socio-Economic Resources

### *6.10.1 No Action*

The No Action alternative would not affect socio-economic resources.

### *6.10.2 Recommended Plan*

The recommended alternative will temporarily disrupt traffic flow patterns along both South Kingston Road and West Kingston Road. The culvert improvement projects will be constructed in separate years, so the traffic disruption will not be cumulative.

It is proposed to construct the South Kingston Road bridge as a staged construction, therefore allowing for one lane to remain open at all times during the construction process. Residents commuting between the Indianola and Kingston communities will therefore not be detoured. During construction, emergency service vehicles will continue to be able to use South Kingston Road. Flag persons and other personnel will be used to safely direct traffic through the construction site. Occasionally during construction, it may be necessary to temporarily close the road in the vicinity of the South Kingston culvert for brief periods of time, likely not exceeding 2 hours in duration. These temporary closure times may be necessary to allow for movement of heavy equipment from one side of the culvert to the other, and to allow for the placement of the 95-foot long bridge girders. These closure times will be minimized and will be timed to occur during non-peak periods of use.

West Kingston Road will be entirely closed to through traffic during the construction of the West Kingston Road Bridge. Through traffic from Miller Bay Road NE will not be allowed to use

West Kingston Road, and will be detoured north to State Route 104 and then south on Barber Cut-Off Road. Flag persons and other personnel will be used to direct traffic and avoid problems. Local access on West Kingston Road will continue, however. There are two schools located on West Kingston Road, between Miller Bay Road NE and the proposed construction site – Spectrum Alternative school and Kingston Junior High school. Access to the schools from the Kingston area will be detoured via Barber Cut-Off Road, State Route 104 and Hansville Road NE. The road closure will also have an affect on local access for emergency service vehicles.

Underground utilities present along the roads will be temporarily moved and then relocated under the bridge decking. Overall, there will be temporary effects on traffic, but these will be minor, and there will be no long-term effects on socio-economic resources.

## 6.11 Hazardous and Toxic Wastes

### *6.11.1 No Action*

The No Action alternative will have no effects on hazardous or toxic materials.

### *6.11.2 Recommended Plan*

The recommended alternative would have no expected effects on hazardous or toxic materials or wastes, because there are none known in the project area. If any waste material is encountered during construction, it will be removed and disposed of in an appropriate landfill. Washington State Department of Ecology (DOE) will be contacted in the event of any materials encountered during construction.

During construction, the use of appropriate BMP control measures will be required of the contractor to prevent construction equipment fuel, lubricants and wash-off from entering the estuary.

A preliminary (Level 1) assessment of hazardous, toxic and radioactive wastes (HTRW) was conducted for the Carpenter Creek estuary project area, and is included in Appendix D.

## 6.12 Environmental Justice

There are no low-income or minority communities in the project vicinity. Overall, there will be no adverse effects on low-income, minority or subsistence populations. The project may incrementally benefit tribal fisheries by improving rearing opportunities and production for juvenile salmonids.

## 6.13 Cumulative Impacts

A number of cumulative impacts have already occurred in and around the project area, including the construction of roadways across the estuary, urban and rural residential development within the Carpenter Creek watershed, clearing of forests, increased agricultural development and runoff, bulkheading of marine shorelines, and fish and shellfish harvesting. The loss of habitat and blockage of access to habitat are major factors leading to population decline of fish and wildlife species in western Washington. This project will incrementally reverse some of these cumulative impacts by providing unhindered fish passage to Carpenter Creek and its estuary. This project will also be compatible with other actions the County is undertaking to preserve habitat in the watershed (acquisition of Carpenter Lake and other headwater areas). This project will also create a much better connection between the forested uplands and the estuary for both fish and wildlife migrations.

# 7. COORDINATION AND LOCAL SUPPORT

## 7.1 Environmental Compliance and Environmental Statutes

This project is not expected to have any significant adverse effects on the environment, and as such, an Environmental Assessment (EA) has been prepared, and is integrated into this feasibility report. Following review of this Draft Integrated Feasibility Report/Environmental Assessment, a Finding of No Significant Impact (FONSI) will be prepared. Consultation under Section 7 of the Endangered Species Act (ESA) is on-going.

Additional permits and approvals that will be necessary in support of this project include a Section 404 Clean Water Act equivalency analysis, Coastal Zone Management consistency analysis, Section 401 Water Quality Certification from the Washington Department of Ecology, and a Hydraulic Project Approval (HPA) from the WDFW. A grading permit may be required from Kitsap County. The local sponsor will be responsible for obtaining the HPA and any local permits.

## 7.2 Public and Agency Coordination

During both the plan formulation phase and the feasibility phase, the Seattle District USACE coordinated project alternatives and plans with the Kitsap County Department of Public Works, the Kitsap County Department of Community Development, the Kitsap County Conservation District, the WDFW, the Suquamish Tribe, and the Stillwaters Environmental Education Center. The United States Fish and Wildlife Service (USFWS) has been participating through the USFWS coordination Act. The USFWS report can be found in Appendix G. A biological assessment (BA) is currently being prepared by the Seattle District USACE and will be submitted to both United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) for concurrence. Further coordination with these resource agencies will be required during development of plans and specifications to receive all necessary permits.

On March 26th, 2003, the Seattle District USACE and Kitsap County sponsored a public meeting in Kingston, WA to present the recommended plan to the community. Residents from the Carpenter Creek area, including Bill Reynolds, Cindy Alexander, Mike Chesmore, Suzanne Arness, Patricia Talmage, Carol Hines (Knutson), Mary Beth Bealieu, Duke Kurpgeweit and Sandra Kurpgeweit provided comments and historical perspective on the project. On April 30th, 2003, the USACE participated in a community open house at the Kingston Junior High School, where the opportunity was taken to reach out to a larger audience and to display graphics of the proposed project.

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# 8. SUMMARY AND RECOMMENDATIONS

## 8.1 Project Summary

Carpenter Creek estuary is a moderate sized estuary, providing more than 30 acres of high quality habitat in a crucial location in eastern Puget Sound for migrating salmonids. The morphology of the estuary has been continually adjusting to the anthropogenic alterations that have occurred both within the estuary itself and within the Carpenter Creek watershed, resulting in diminished habitat quality for salmonids. The proposed restoration project addresses some of the anthropogenic alterations within the estuary, and seeks to restore natural processes and functions that will benefit salmonid species. The project would address alterations related to the processes that influence biologic habitat composition and habitat function; namely estuarine hydrology, local hydraulics, and geomorphology.

The recommended plan is comprised of several structural restoration measures, which include:

- Replacing a 10’ by 10’ box culvert with a single span bridge opening
- Replacing a 60-inch diameter circular culvert with a single span bridge opening
- Excavation and removal of abandoned road bed embankment fill
- Filling of scour holes
- Reestablishment of estuarine and riparian plantings
- Placement of large woody debris

The 35% feasibility level cost estimate for project implementation is $3,999,900. This estimate includes costs associated with, feasibility, construction, escalation, contingency, engineering and design, supervision and administration, and LERRD. The project is proposed to be constructed in two phases, with Phase I scheduled for fiscal year 2006 and Phase II scheduled for fiscal year 2007. Federal expenditures in fiscal year 2004 are $340,000 and are estimated to be $90,000 in fiscal year 2005, $1,465,600 in FY06 and $704,300 in FY07.

The local sponsor is Kitsap County, and as per federal regulations, will be responsible for funding 100 percent of the costs associated with operation, maintenance, repair, replacement and rehabilitation (OMRR&R). First year O&M costs for Phase I of the project were estimated as $8,400. O&M costs for years 2 through 5 were estimated as $5,000, and for all subsequent years were estimated as $4,300. First year O&M costs for Phase II of the project were estimated as $14,800. Phase II O&M costs for years 2 through 5 were estimated as $4,070, and for all subsequent years were estimated as $1,920. Assuming a 5.875% federal discount rate, the total present worth of the 50-year operations and maintenance plan is $75,100 for Phase I and $50,100 for Phase II. These estimates of present worth are equal to an average annual equivalent cost of $4,700 for Phase I and $3,100 for Phase II. The OMRR&R cost and the monitoring cost are expressed as present worth values assuming a 50-year project life and a 10-year monitoring period, respectively.

Expenditures associated with post-project monitoring were assumed to be funded 100 percent by the non-federal sponsor. However, according to ER 1105-2-100 (USACE 2000), post project monitoring costs may be federally shared with the non-federal sponsor if the monitoring program is clearly defined, justified, and the period of cost shared monitoring does not exceed five years following completion of construction. In this case, the federal share of the monitoring costs shall not exceed one percent of the total first cost of ecosystem restoration features (USACE 2000). Therefore, if federal review of the monitoring plan and cost estimate proposed in this feasibility report determines that it is justified to assume federal contribution to post project monitoring, then a portion of these costs can be included as federal costs.

The draft-monitoring plan prepared for this feasibility report identified annual costs for six monitoring task indicators for a 10-year monitoring plan period. Assuming a 5.875% federal discount rate, the total present worth of the 10-year monitoring plan is $152,200. This estimate of present worth is equal to an average annual equivalent cost of $9,500 when spread over the 50-year period of analysis. The average annual equivalent cost over the 10-year monitoring period is $20,600.

## 8.2 Conclusions

This study has included an examination of potential and practicable alternatives for meeting the project objectives. The Seattle District USACE, Kitsap County Department of Community Development, Kitsap County Department of Public Works, the Kitsap County Conservation Commission, the Washington State Department of Fish and Wildlife, the Suquamish Tribe, Stillwaters Environmental Education Center, and various property owners throughout the project area have all provided input and direction for this study.

The recommended plan is an incrementally justified and cost effective alternative that is within the funding authority of the federal government's Section 206 ecosystem restoration program. The recommended plan will provide for significant long-term fish and wildlife benefits with reasonable construction and O&M costs.

## 8.3 Recommendations

The recommended plan, as documented in this report and the attached appendices, has been developed to a 35% feasibility level design. The design plans and the MCACES cost estimate are included in Appendix E. This documentation provides the formal groundwork to initiate project permitting and to develop the final plans and specifications for the implementation of this restoration project. It is therefore recommended that this project be authorized to move forward to the subsequent design phase.

As this project progresses from the feasibility level through final plans and specifications, there are several critical issues that should be considered in more detail. Each one of these issues will have a relative impact on the project costs, and therefore, it is recommended that they be addressed as soon in the design process as is feasible. The critical issues are summarized below.

- Continued discussions with the resource agencies that oversee state and federal protected species are necessary. The presence, or potential presence, of several protected species in the project vicinity is a driver in defining the available construction window. This is especially crucial for Phase I of the project, where the estimated construction period is approximately 16 weeks (112 calendar days). Considering the closure periods for each of the protected species in the project vicinity, a worst-case window for construction has been identified as August 16th through October 14th (60 calendar days). It is understood that there may be some flexibility on either end of this window, depending upon the conclusions of the biological assessment (BA).

- Continued discussions with U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Washington State Department of Ecology (DOE), Washington State Department of Fish and Wildlife (WDFW) and the Suquamish Tribe is recommended in regards to further defining the cofferdam/water control construction techniques that will be allowed during construction of each of the bridges. These discussions will ensure that all construction technique limitations are well defined early in the process, and that all associated construction costs have been included in the engineering estimate. The construction contractor is ultimately responsible for providing the final plan for any necessary cofferdam/water control operations, and will be required to do so within the guidelines specified in the appropriate permits. However, it is necessary to define any and all limitations so that a reasonable engineering cost estimate can be prepared.

- Additional geotechnical analysis is required so as to develop final recommendations for the foundation designs for both clear span bridges. During the feasibility design, preliminary recommendations for foundation designs were provided (GeoEngineers 2002), and are included in Appendix B (Preliminary Geotechnical Engineering Services). These recommendations provided a planning level basis for determining the design and costs relative to the bridge foundations. However, more detailed analysis is necessary to more accurately estimate the magnitude of lateral forces, to include the potential for earth loading that would result from lateral spreading of the roadway embankments during the design seismic event. It is recommended that this additional analysis be conducted as early in the subsequent design phase as is feasible.

- Additional candidate properties for temporary construction staging need to be identified. Since the project will be implemented in two phases, it is likely that the same site(s) could be used for staging during each phase. Approximately 15,000 square feet of a parcel owned by Kitsap County Roads Department (parcel # 34270210058) has been identified as a temporary construction staging site. However, it is estimated that at least another 50,000 square feet of contiguous land area will be necessary to support each phase of project implementation.

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**DEPARTMENT OF THE ARMY**
**SEATTLE DISTRICT, CORPS OF ENGINEERS**
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REPLY TO
ATTENTION OF

CENWS-PM-PL-ER

CARPENTER CREEK SECTION 206 ESTUARINE HABITAT RESTORATION
KINGSTON, KITSAP COUNTY, WASHINGTON

**Draft** FINDING OF NO SIGNIFICANT IMPACT

**1. Background.** Undersized culverts through two road embankments in Kingston, Washington restrict the volume of tidal waters entering the Carpenter Creek estuary. These hydrologic restrictions have dampened tidal heights and caused a reduction in the area inundated. The depth, frequency, and duration of tidal inundation is insufficient to maintain salt marsh habitat in the upper lobe of the estuary as a result of these culverts. High velocities through the road embankments limit fish passage and have created large, deep scour holes adjacent to the culverts. The culverts have also limited sediment transport, which has resulted in shoaling and a reduction in the number of tidal channels within the estuary. The proposed project will replace the two undersized culverts with single-span bridges in order to restore full tidal hydrology to approximately 33 acres of subtidal and intertidal habitat in the Carpenter Creek estuary.

**2. Authority.** Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303, as amended) authorizes the Corps of Engineers to carry out habitat restoration and protection projects. Kitsap County is the non-Federal sponsor for this project.

**3. Proposed Action.** The proposed action consists of five restoration measures:
(1) replacement of the 10 x 10 foot box culvert at South Kingston Road with a single span bridge 95 feet in length; (2) replacement of the 5 foot diameter culvert at West Kingston Road with a single span bridge 60 feet in length; (3) filling of scour holes adjacent to South Kingston road with approximately 2,655 cubic yards of imported and native material; (4) excavation of approximately 1,300 cubic yards of material along an abandoned road embankment adjacent to West Kingston road; and (5) planting of native riparian and salt marsh species in areas disturbed by construction or colonized by invasive species.

**4. Summary of Impacts.** A draft Integrated Feasibility Report and Environmental Assessment has been prepared pursuant to the National Environmental Policy Act (NEPA) for the proposed action and is attached. The draft Feasibility Report/Environmental Assessment describes the environmental consequences of the project, which are briefly summarized below.

Construction at the South Kingston Road site will likely require approximately 16 weeks to complete due to the need to keep one lane of the road open during construction and to operate during suitable tidal cycles. As such, construction activities at the South Kingston Road crossing are proposed during the end of the bald eagle nesting season and at the end of the bull trout closure period in order to complete construction during the limited period of seasonal low tides during allowed construction hours. A specific construction sequence and monitoring plan is proposed to minimize disturbing activities during these periods. This sequence is currently being coordinated with U.S. Fish and Wildlife Service and NOAA Fisheries Service through informal consultation of the Corps' Biological Assessment to assure that the project is 'not likely to adversely effect' listed species.

Impacts from the replacement of the culverts and construction of the bridge abutments and new tidal channel will generally be highly localized in nature, short in duration, and minor in scope. While there will be a loss of subtidal habitats for benthic invertebrates and demersal fish species from filling the scour holes and construction of the new tidal channel, this loss is expected to be temporary as benthic populations are expected to recolonize the new intertidal areas quickly. There would likely be small-scale, temporary increases in turbidity within the construction area as a result of restoration activities. Increases in turbidity will be localized and temporary. In order to reduce these impacts and potential related effects on juvenile salmonids and their prey species, the majority of 'in-water' construction work will take place between July 15 and October 31.

Approximately 80 cubic yards of fill material would be placed below the mean higher high water to construct the roadway embankment at the South Kingston Road crossing, raising the elevation of approximately 2,100 ft2 of existing intertidal habitat. This loss is offset by the net decrease of 972 cubic yards of fill that will be removed, resulting in an increase of 13,616 square feet (0.31 acres) of intertidal habitat in the tidal channel beneath the bridge.

Impacts from this restoration project should not be significant, either individually or cumulatively. Impacts to the human environment would also be temporary and localized. There will be no effect on known Native American and cultural resource sites. There will be no adverse impacts to fishing rights of Native American Tribes. Construction activities may temporarily increase air emissions and noise in the vicinity of the construction sites, alter the flow of traffic through the construction sites and associated detours, and decrease the aesthetic attractiveness of the general area during construction. Noise, traffic, and air quality issues will be managed through implementation of appropriate control plans. Thus, these impacts will be temporary and highly localized.

**5. Finding.** Based on the analysis detailed in the draft Feasibility Report/Environmental Assessment (attached) and summarized above, this project is not a major Federal action significantly affecting the quality of the human environment and, therefore, does not require preparation of an environmental impact statement. A 404(b)(1) evaluation is being prepared and a 401 Water Quality Certification is currently being sought from the Washington Department of Ecology.

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| Date | Debra M. Lewis<br>Colonel, Corps of Engineers<br>District Engineer |

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